PROCEEDINGS

OF THE

American Philosophical Society

Held at Philadelphia for Promoting Useful Knowledge

VOLUME 102, NUMBER 4 AUGUST 27, 1958

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THE AMERICAN PHILOSOPHICAL SOCIETY

INDEPENDENCE SQUARE

PHILADELPHIA 6

1958

PUBLICATIONS

OF

The American Philosophical Society

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PENROSE MEMORIAL LECTURE

SOME SUGGESTED ADJUSTMENTS IN THE USE OF OUR RESOURCES

MARION B. FOLSOM

U. S. Secretary of Health, Education, and Welfare

(Read April 24, 1958, by Dr. Aims C. MacGuinness, Special Assistant for Health and Medical Affairs)

I AM honored indeed to address this distinguished assembly. In considering a suitable subject I have looked a bit into the major interests of your society over its long and fruitful years. I find that Benjamin Franklin proposed that the society interest itself, among other things, in "all philosophical Experiments that let Light into the Nature of Things and tend to increase the Power of Man over Matter and multiply the Conveniences and Pleasures of Life."

The emphasis on the power of man over matter sounds very modern and brings to mind the startling scientific and technological developments of our times. These advances, along with social and economic progress, have already multiplied the conveniences of life to an extent undreamed of in Franklin's day. Now we stand on a new threshold, peering into the unfamiliar rooms of an age of nuclear energy and the fulfillment of one of man's oldest dreams, the opening of the doors to the universe. Undoubtedly in the age just beginning the conveniences of life will be multiplied again to an extent unimagined even in our own day.

But what of the second element in Franklin's prescription for your interest and effort? Has man on the whole found the way to *pleasures* in life today far beyond those of Franklin's time? Does life today really provide more opportunity for personal fulfillment and satisfaction? Will the unfolding age of nuclear energy and exploration of space lead man, generally speaking, to a more deeply rewarding life?

It is dangerous to generalize on these questions. Society cannot *decree* or *provide* a more satisfying life for the individual man. But perhaps society *can* give the individual a better chance to find satisfaction and happiness for himself, within himself. Many of the burdens that restricted man's chances for a more rewarding life have been lifted since Franklin's time. Some of the shackles of disease and poverty and ignorance have been broken. More and more people find that life is less and less a back-breaking span of toil and struggle for bare subsistence.

In the new age we are entering, our society will have the resources and the power, the opportunity, to banish many more of the burdens that have beset mankind through the centuries. For the first time in human history a great nation will have the material resources, the wealth in being, to eliminate hunger and scarcity and poverty, to provide a decent level of living, for a *whole* people. Life may no longer *have* to be, for anyone, a grim struggle for bare existence.

Our society also will have, or *can* have, the knowledge and power to abolish—to a far greater extent than ever before—age-old burdens of disease and disability and pain. We will have far greater resources and opportunities than ever before to erase ignorance and to encourage more effectively the intellectual development of many more of our young people.

I say our society will have the resources and the power to do these things. But will we *use* this power—and use it wisely? Will we have the vision to assign the proper priorities for the investment of the resources available? Will we take a sufficiently long view in setting our goals? These are crucial questions.

We will not, of course, be wise enough to do all that we could or should do for the betterment of man's lot. But I suggest several directions in which, I believe, our society can and should move in order to grasp more fully more of the opportunities now before us.

One of the drags on the future is the human tendency to take the short and expedient view. Our society tends too much to allocate time and effort, thought and money, to those things which bring direct and tangible returns, here and now. We look for immediate, material, personal benefits.

I do not suggest a change in human nature. Man does quite properly look out for himself. Immediate, personal, and tangible goals should and will require a large part of our effort and funds. But in the long run man also receives great rewards from social investments designed not so much for returns to himself now but more for re-

turns to the group as a whole in the future—investments, so to speak, for the common good; for long-term, intangible, even unforeseeable returns.

For many years millions of persons contributed money to fight poliomyelitis without knowing when or whether victory would be achieved. Some of those who contributed undoubtedly were later stricken with the disease themselves—but they had not made this investment for themselves, or even necessarily for their generation. And yet, because so many took a long view and supported their vision with action, the scourge of polio is on the way out and man has one more triumph over pain and disability.

It seems not too much to hope that our generation will take a long look at those movements and trends in history which have been most constructive for mankind in the long run, and we may be wise enough to realize a little more clearly the value of investing a greater share of our resources for returns over the long span. In suggesting we make history an ally of our judgment, I do not align myself with the cynic who said that "what we learn from history is that we don't." It may well be that the distance man has yet to travel to true rationality is greater than the distance he has already covered toward that goal. But to say at this point that man is not sufficiently rational to think and act beyond his own immediate needs and interests would be, indeed, to foreclose the doors to further human progress.

We are well aware that the unknown in man's history greatly exceeds the recorded chapters. But the historical records for the 6,000-odd years for which we have them can be a fruitful source of guidance. We should be more perceptive now as to the nature of those long-term investments which yield the greatest good to man. We can apply judgment as to what proved over the long run to be right and wrong for society in past years, and therefore bring some additional light to the question of how best to allocate our resources now.

I incline to the proposition that man's progress is related to the emphasis he gives to the development of man's own capacities and abilities. A phrase in Benjamin Franklin's injunction for your Society suggests the kind of priority I have in mind. The phrase is "man over matter."

In the main we as a people seem inclined to concentrate our energies on the production of things, rather than on the development of human capacities and resources. We readily invest a large part of our effort and funds toward increasing the material matter in our civilization. The outpouring of consumer goods is one of the landmarks of our society. Certainly there is nothing wrong with this, particularly so long as the multiplication of material goods ultimately serves the best interests of men. But we do not invest nearly enough time and thought and money in the intellectual and moral, social, and physical development of the man who makes all these material things possible. We retard the progress of our society by a pinch-penny attitude toward investments in health and education, in fundamental research, in improving the functioning of government, and the relations of peoples, in artistic and cultural satisfactions for man.

In considering the allocation of our resources, we should bear in mind that technological improvements have done too little to increase the output of human services, such as teaching, medical care, social work, and research. In the production of material things our output per person has increased enormously. In agriculture it used to take one farmer to feed four other people; today he feeds twenty. In industry, too, production per person is constantly increasing. But, in general, a teacher or doctor or social worker can serve no more persons than twenty or thirty years ago. The electronic brains can aid research by doing amazing things in computation; but the imagination and the reasoning which make research productive still depend upon the human mind. The increased complexity of modern life has multiplied the social and economic and political problems with which we have to deal, and the human resources for dealing with them are strictly limited. It seems essential, therefore, that we direct an increasing proportion of our resources into these lines of service, and increase our emphasis on the development of those human qualities and capacities that are so indispensable to progress.

In general, under existing conditions, the competition of the market place does not direct our resources toward such ends to the extent desirable for the long-run welfare of the Nation. In our day-by-day living everyone, or every family, must try to balance his budget, so to speak. Everyone must direct his efforts so that the market will give him an income that will keep him going. If these investments in what may be called our human capital, our intangible social capital, have sufficient market value and bring sufficient returns, the individual and the family will usually adjust their budgets and make the expenditure. But sometimes this is not possible.

In education, for example, while the value of

an education in terms of increased earning power has been amply demonstrated, the individual or the family sometimes does not have the money to invest and cannot get it. And to the family with limited means the benefits to the individual may appear uncertain and far off compared with other more tangible possessions here and now. Then, too, as things are, investment in some of the most essential fields—preparing for teaching for example—will never "pay off." The same time and effort and money spent otherwise will bring greater material returns. The result is that our human and material resources are drawn into other fields where the returns are more direct, more certain, and more immediate.

There are many fields where greater attention is needed if our society is to grasp more fully more of the remarkable opportunities now before us. I should like to discuss two of these fields as examples of the need for a shift in emphasis in the use of our resources.

One of the most fruitful of all fields for the investment of our resources, over the long run, is more and better research. Although expenditures for research have increased rapidly over recent years, our society still does not invest nearly enough in research. Perhaps even more important, it does not emphasize sufficiently the *kinds* of research which would probably yield the most far-reaching benefits over many years ahead.

According to a recent study, total expenditures for research and development have expanded about thirty times since 1940, from $350 million to $10 billion in 1957. Other estimates put the total much higher. Most of this research, however, is not of the sort that adds to our basic knowledge. Much of it has to do with the application of knowledge in the development of new industrial techniques or new products, or even the dressing up of old products to make them more attractive in the market place. It is applied research, rather than basic research.

I do not suggest that applied research has little value. It is largely applied research which has brought about the amazing technological developments in this country and helped give us an income which can supply all our basic needs and leave a substantial margin for the kind of investment of which I am speaking. But we need a deeper appreciation of the fact that applied research only builds upon and exploits the knowledge first developed by basic research.

Basic research may yield no dividends at all in any special way at any particular time or place, or to any specific individual or group. It is a pure search for knowledge and truth. The basic researcher lets others worry about the application or usefulness of the new light he brings to the world. But we are selling future generations short because we have failed to keep this wellspring of knowledge flowing as fully and freely as it should.

The Hoover Commission, in 1955, said: "We owe to basic research the fabulous improvement in the health of our Nation; the greatest productivity known to man; the weapons of defense which have protected our independence; and our knowledge of the laws which govern the universe." Dr. Bronk, President of the National Academy of Sciences, has said that if there is any field of activity which is the proper province of the National Government it is the encouragement of basic research.

President Eisenhower has pointed out that more than 90 per cent of research and development expenditures even by the Federal Government were going for applied research. Only a small fraction of Federal funds, the President said, "are being used to stimulate and support the vital basic research which makes possible our practical scientific progress." Much more of our talent and resources should go into the research which is most fundamental to all long-range progress.

I am occasionally disturbed, however, by some of the arguments advanced on behalf of basic research. These arguments leave the impression that basic research is desirable only or mainly because it opens the way for applied research. Basic research is thus justified not so much as a thing of value within itself but more as a kind of doormat just one step removed from the *real* thing. If our society is to move wisely to bring into reality more of the promise of the future, we will have to develop a deeper and broader respect for the exciting and singular process by which the human mind reaches from the known into the unknown. Each discovery of new knowledge in itself fuels the process of acquiring still more new knowledge. Each step forward has its own virtue—frequently uncertain, often mysterious, but always of consequence in its own right as another particle in the painstaking process of acquiring new knowledge.

I am reminded that a British Prime Minister one day came upon a scientist busy at work on a seemingly obscure experiment. "I say," the Prime Minister asked, "what are you making there?" "I don't know," the scientist replied, "but sooner or later you will find a way to put a tax on it."

In addition to the need for greater emphasis on

basic research, there are specific fields for fruitful research which are sadly neglected today. There are, in fact, absurd disparities between the actual or potential cost of some of the problems of our times and the amount we have been willing to invest to find out more about the cause and solution of these problems. I will cite just briefly some of these fields where this disparity is greatest and where more research would be the soundest kind of long-term investment.

We are spending billions of dollars to develop atomic and nuclear power, and tens of billions to adapt that power to weapons of war to keep our country safe from aggression. But we are investing too little for research into the nature and extent of radiation hazards to health, to learn how to keep our people safe as they make and use this new power. We are readily investing additional billions in badly needed new highways. But research to learn more about the fundamental causes of highway accidents, and to find more effective ways to reduce the suffering and terrible waste of life caused by accidents, is on a very small scale indeed.

As a by-product of our technological achievements and urban growth, we are fouling both the water and air around us at a disturbing rate. Pure water and pure air, it seems, should be the birthright of every man, woman, and child in the country. And yet, unless we invest more in research and conservation in this field, we are threatened with a lack of pure air and water for our own generation, to say nothing of generations yet to come.

We spend billions of dollars every year for immediate relief to needy persons, but we invest only a pittance in research to find out more about the causes of dependency and ways of helping financially needy persons to a more satisfying life of greater independence. We are spending more than $19 billion a year for education, public and private, but we invest less than one-tenth of 1 per cent of that sum for research and factfinding to learn more about the problems of education and to seek improved methods of education.

We express great concern about the growing problem of juvenile delinquency, and we spend vast sums for courts and jails and other facilities for handling young people in trouble. But the children only reflect, in one way or another, the attitudes, the standards, the morals of the homes and schools and communities in which they grow up. What in our society is causing the disturbing increase in broken homes and juvenile delinquency? There are few areas in which additional investment would pay bigger dividends in the long run.

All these fields for fruitful research directly concern the health and welfare of man himself. In the broad spectrum of our national investments in research, we have concentrated large sums in the search for knowledge, or the application of knowledge, in the production of more and better material things. This has yielded tremendous returns and undoubtedly we should and will expand investigations in this field. But I suggest that research in relation to man, and to his social and political institutions and problems, is equally important and much more neglected. It is perhaps a slight symptom of this difficulty that recently the Government provided pay increases to attract more people into physical sciences but neglected to take the same step in the field of biological sciences.

Only in recent years has our society begun to make a substantial investment in one of the most rewarding of all fields—medical research. Expenditures for this purpose have increased from less than $100 million in 1948 to about $330 million a year now. Yet we are only beginning to scratch the surface of some of the really difficult and growing problems such as cancer and heart disease and mental illness. Too many people think of medical research as a search for some nostrum, some dramatic cure of a particular disease. But, as a rule, progress is made slowly by putting together bits of basic knowledge which have been developed over the years by patient investigation by hundreds of people who will always remain unknown.

Cancer, mental illness, and heart disease, for example, are not even diseases in the usual narrow and specific sense of the term. They are not like yellow fever or malaria or typhoid fever which can be prevented by exterminating a single carrier. Each appears to be a whole family of diseases and results from a shadowy multiplicity of causes. There is no single, definitive line of attack. A far-seeing research program necessarily consists of innumerable, separate investigations, looking at some of life's most complex processes in hundreds of different ways, from different angles. There is a danger, I believe, that research will be concentrated too much on treatment and too little on the fundamental nature of the disease, its cause and prevention.

A governor addressing the national governor's conference stated he had asked his legislature for one-quarter of a million dollars for research in mental health and had been refused. Yet if he had

asked for $5 million for institutions to care for the mentally ill, he said, his request would have been granted. This is typical of our tendency to think too much in terms of immediate, direct, foreseeable results. We still fail to recognize sufficiently the tremendous long-range importance and value of investment in the search for knowledge as such.

Altogether, despite the demonstrated bright promise of medical research for human welfare, only 3¼ per cent of all our research expenditures are in health and medical problems. Surely the health of the people deserves a larger portion of our investment.

But progress in medical research is limited, even if more funds were available, by a lack of highly trained research scientists. Here again is evidence of our tendency to neglect long-range and intangible investments, particularly in human resources. Our society has provided pitifully poor and short-sighted support of its medical schools, which train both the scientists for research and the physicians who bring the fruits of research to all the people. Rapid advances in medical science and the enormous increase in population point clearly to a need for many thousands of additional doctors over the years ahead. Yet teaching facilities in many medical schools already are overburdened, and much of their equipment is out of date. Many schools are critically short of funds even for current operating expenses, to say nothing of the great expansion and improvement that is needed. Unless our society acts quickly to increase greatly its investment in medical education, we will be desperately short of physicians and research scientists, and we will fail to grasp a large part of the opportunity we now have for the improvement of the health of the American people.

In the effort to direct more funds and energies toward those aspects of our society which are most constructive for mankind in the long run, education must also be given a prominent place, along with research. From the beginning of our national life we have seen with varying degrees of clarity that one of the foundations upon which the whole structure of human welfare rests is knowledge and the development of the human intellect. We can hardly express this theme better than did the Continental Congress of 1787 in its familiar declaration: "Religion, Morality, and Knowledge being necessary to good government and the happiness of mankind, schools and the means of education shall forever be encouraged." We have been justly proud that one of America's greatest contributions to modern civilization is our pioneering development of the concept of free and universal education. It is because we believe this is one of our greatest national assets that we are concerned over any serious deficiencies in our schools.

And there are grave deficiencies today which need to be remedied. But let me make one thing perfectly plain. I do not believe we need to alter our basic concepts of the meaning and purpose of education. We should not swerve from our fundamental conviction that the purpose of education is to enable *each* individual to achieve his own highest potential in a free and democratic society.

This means that for many young people—those who are intellectually and academically gifted—we need to provide more challenging academic courses of study, to set higher standards for intellectual achievement. For other young people—those whose gifts are in a different direction—we need to provide effective courses of vocational and technical training and other studies which will help them, also, get the most out of life and contribute the most to our society.

I am concerned over one aspect of the current re-examination and great debate in education. There are some sincere supporters of education who seem to advocate a return to almost total emphasis on fundamental academic subjects. There are other equally sincere supporters of education who seem to advocate an emphasis on so-called "practical" subjects at the expense of fundamental academic studies. In my opinion, the final judgment should not be made on an "either–or" basis between academic subjects and other worth-while educational goals. There is need for improvement in *both* directions, if we are to advance toward our goal of an education for each child according to his *own* personal abilities and interests.

Dr. John W. Gardner of the Carnegie Foundation for the Advancement of Teaching has made a plea which strikes at the core of this issue. He said:

> An excellent plumber is infinitely more admirable than an incompetent philosopher. The society which scorns excellence in plumbing because plumbing is a humble activity, and tolerates shoddiness in philosophy because it is an exalted activity, will have neither good plumbing nor good philosophy. Neither its pipes nor its theories will hold water.

The change I believe we should make is not to turn our sights toward a different educational goal but to train them more steadily and more effectively on the very target which has long been established. We need to invest much more attention and effort and money to see that each boy and girl does in fact, through education, have an oppor-

tunity to develop to his or her highest potential. Our society does not give the development of intellect and knowledge and skill—in *all* fields—the high priority that is needed.

Somehow our conscience does not seem to be disturbed enough by the fact that our public schools are short this year by more than 140,000 classrooms and by 135,000 qualified teachers. Somehow the richest nation on earth is not ashamed enough of the fact that it pays college teachers, on the average, a little over $6,000 a year. In elementary and secondary schools in twenty states, the average salary for schoolteachers ranges somewhere below $4,000—down to as low as $2,500.

Our deficiencies in education, even as the shortcomings in research, are two symptoms among many of the failures of our society to invest enough of its energies and funds in social objectives which would bring great rewards not only to individuals but to the community as a whole. We are not willing enough to forego immediate, material, personal wants in order to achieve the larger and longer-term benefit for all. But unless we make an adequate long-term investment in human capacities and resources, ultimately we undermine fundamental sources of strength and progress which make possible our economic abundance, our national security, our freedom itself.

I referred earlier to the hope that we might, in applying vision in the use of our resources, benefit from historical guidance. One of the most elementary facts to be learned from the 6,000 years or so of recorded history is that people have been getting closer and closer together in terms of time and distance until virtually all peoples live today in an era of closely knit international interests.

As the basic interests of people everywhere became increasingly intertwined, so human relations became more and more the all-controlling, all-embracing element to human harmony and human progress. No discussion of the use and priorities of America's resources, of the framework of America's vision, could be complete without recognizing we are simply a part of a larger world, in which we must not only live but to which we must contribute in many ways, and from which we have much to receive. Without this recognition we fail before we even begin our efforts to apply a longer view.

Let me cite two elementary facts that bear on our relations with the rest of the world. We have within the United States about 10 per cent of the free world's population. But with this population we have achieved more than 55 per cent of the free world's mining and manufacturing production. When we start to apply vision and priorities to the use of our resources, it does not follow, in my judgment, that we should—nor that we can, in fact—think of our capabilities for *our* benefit alone. If we do, then we are profoundly indifferent to a major lesson of history and our own true self-interest.

Some authorities tell us that recorded history demonstrates a basic and persistent conflict between peoples, which has had considerable influence in the rise and fall of one culture after another. This conflict is sometimes described as the conflict between the "haves" and the "have-nots." One of the reasons cited for the conflict is that the "haves" tend to develop contempt for the "have-nots," and the "have-nots" tend to develop a sense of outrage against the "haves." History is studded with the collapse or overthrow of a succession of highly developed cultures, considered in the material sense, by so-called lesser cultures.

I do not fear so much that, as a matter of national policy, our intentions and actions will not be motivated sufficiently by generosity and a willingness to share. I think that, in the end, enough of us will realize that generosity and sharing are in our own best self-interest, and, ultimately, in the welfare of all mankind. These are not the points that trouble me the most. My deeper concern stems from something more basic and far more subtle—the intricacies and pitfalls in human relations.

To be well-intentioned and generous is not enough. We must unlock the secrets of how to live with others without creating hostility toward us because of our wealth and power; of how to share our capabilities—our wealth, our knowledge, our technical competence, our defense of freedom—without creating animosity. And we cannot do this without sharing in the human experience of humility. It is hard to learn how best to give. It is even harder to learn how to receive. We have a long way to go on both counts.

It is this area—the arena of human relations—that requires the supreme test of vision and wisdom. And I believe that more of our resources could well be apportioned to fundamental investigations which may shed light on how we can carry out our peaceful role in the world without falling victim of our own faulty vision or being made the victim of our own virtues.

The world in which we may be seconds away

from mutual destruction is not a world in which we can afford to be centuries away from mutual understanding.

But even with the vision and the wisdom, the will to act in the many areas that need greater attention, we need to ask a further question. How can such vision and will be expressed effectively? What will be the *means*, the mechanics, for reaching such constructive goals? Who will pay the cost of these investments, and how?

In our society there is no single, monolithic mechanism for accomplishing these ends, nor should there be. There is a multiplicity of sources for the funds and efforts required, a variety of avenues for their application.

Some of the decisions to direct money and energies in the directions suggested may be made by millions of individuals and families, acting in many different ways in their own lives and with their own resources. For some families, this may mean less emphasis on immediate comforts and more emphasis on health or education or something else that holds greater promise for the future. Much of the needed investment in larger human resources will come through voluntary health and welfare organizations and the great private foundations. Private business, too, is giving increased support to health and education and other social services, not only for its own employees but for the community and country as a whole. Finally, one of the instruments of the people for common action for the common good is their government.

I believe we must use *all* these means and all these sources—each to a greater extent than ever before. We should avoid turning to any one source of funds and effort to meet the problems and opportunities ahead at the expense or diminution of effort by other sources; rather we should seek a combined and concerted advance, a sharing of responsibility to bring about the best results for all the people.

I am puzzled by what some people say about government action to help develop human resources, particularly Federal Government action. The Federal Government is sometimes described almost as if it were a sinister foreign power, apart from our own people—something to be viewed mainly with fear and suspicion. Although our democracy is far from a state of perfection, my own belief is that with modern means of travel and mass media of communication, government, including the Federal Government, is closer and more responsive to the people than ever before. Certainly our Government is no less now than it was in the beginning, a government "of the people, by the people, for the people."

It was Lincoln's view that it is the function of government to do for the people what they cannot do for themselves otherwise, or cannot do as well. This is still a wise prescription. And this same prescription covers a broader range of activities as the population grows enormously, as society becomes much more complex, as people become more and more interdependent.

An increase in government activity is not necessarily evil in itself—the central question is whether the government activity actually provides a needed and constructive service for the people. The *absence* of wise and prudent government action can be more costly in the long run. Sumner Slichter of Harvard has spoken persuasively on the theme that "government is not merely an expense—it is a service-rendering organization that repays its costs manyfold in the services that it renders."

Over the centuries, life for most people has been a struggle for subsistence. Ignorance, poverty, and disease were long accepted as the necessary lot of mankind. Only in the last century or so, and primarily in the last half-century and in this country, have we achieved a level of material welfare which has permitted us, as a people, to set aside larger and larger investments in the development of human faculties and the expansion of the fund of knowledge for the benefit, not only of ourselves and our children but for future generations and other people. Toynbee says: "The Twentieth Century will be remembered as the first age in history in which people have thought it practical to make the benefits of civilization available for the whole human race."

We know now that ignorance and poverty and disease are not necessarily the lot of man. By wise use of the resources at our disposal, we can eliminate or reduce these evils. Man can be more free of these handicaps and hobbles, more free to seek a more satisfying life, each in his own way. By taking the long view, we can re-invest an increasing share of our increasing resources to advance the physical and intellectual and moral development of the people, and to search for further knowledge which will permit continuing improvements. Will we have the vision to do this? Or will we prove once again the ancient saying, "Where there is no vision, the people perish." This is the question that our past achievements present to this generation.

THE PLANNING AND IMPROVEMENT OF EDUCATIONAL FACILITIES

MORRIS DUANE

Lawyer, Duane, Morris and Heckscher, Philadelphia

(*Read April 26, 1958*)

In the next ten years, it is estimated that some forty billion dollars will be expended for educational facilities in the United States. I respectfully suggest that this may present the greatest single opportunity for the advancement of education and educational methods in the history of this country. Properly led, planned, and coordinated, the science of education in the next ten years can make giant strides, perhaps approaching the progress made in medicine, aviation, and other fields from 1941 to 1951. The same basic factors are present, namely, urgent need, dedicated people, available funds, and competition.

All that is required is coordinated planning in the American sense. The facilities built during this period will surely influence the course of American education for many years to come. It is, therefore, important first for those responsible to determine promptly the aims of American education, and to convey that information to those responsible for facilities, planning and construction. Only thus can it be decided which, if any, of the new facilities are truly useful and desirable.

What are some of these new facilities, and how can they be used? Here are a few examples.

Last year the Fund for the Advancement of Education sponsored the use of new educational facilities—television and motion pictures—and thereby created probably the first teacher who is likely to earn $100,000 for teaching high school pupils during one year.

This occurred at Pittsburgh, where the School Board could not obtain a sufficient number of qualified physics instructors. They asked the Fund whether it would finance a course in high school physics offered over television. The necessary arrangements were made, and a leading college professor and lecturer in the field of physics was selected by a committee from the National Academy of Sciences. On a year's leave from his college teaching, he offered a course in physics over Pittsburgh's educational television station, WQED, for the schools of Pittsburgh and the surrounding area. While he taught this course from September until June, the Encyclopaedia Britannica Films Company made motion pictures of 162 class periods. From the sale of these motion pictures to high schools and colleges throughout the country, he received royalties which, together with his salary for the year, will in time net him $100,000 for one year's teaching. In this way the teachers, as professional workers in other fields, are able to extend their services and thereby provide a basis for higher compensation.

A mid-western university, through the use of electronic equipment, can completely and automatically schedule all the classes, times, places, instructors, and students for over 20,000 students taking many courses taught by a large number of professors and instructors.

On a recent Sunday afternoon, the President of this university was surprised to see several hundred students—male and female—milling around this equipment. Inquiry developed that the next day was the opening of the rushing season, and these were the officers of the local fraternities and sororities busy scheduling the times and dates on which prospective pledges would pay their visits. John Jones and Sally Smith would shortly each receive a neat machine-printed card stating the fraternity or sorority and the time he or she was expected there. The machine saw to it that no conflicts were possible.

A private Episcopal church school, by the use of imagination and foresight, is creating a new chapel to seat 800 persons, designed with the altar in the center so that no one of its students is more than a few rows from the minister—the building can be filled or emptied in one minute. The cost of this construction was one-third of the cost of a conventional chapel. It seems not unreasonable to ask the question whether classrooms with the instructor in the center are not worthy of extended experimentation.

The use of sound records is not new. All of us are familiar with the use of such records to teach languages. This was dramatized in World War II when speed was, of course, of the essence. The use of recordings in appreciation of music and other courses is now well established. Well-planned facilities of the future must make provision for rooms where such records may be listened

to by students. The use of tapes for remedial reading and understanding of spoken words should probably be extended to teach better reading and listening habits to all students at a much younger age. The ability to speed up and slow down the sound of words on tape recordings and the passage of written words before the eyes of the student on screens is of great value as a teaching aid. In some experiments, students have been placed in booths from which they could talk directly with the teacher on a direct telephone. At the elementary school level, this system enabled students to speed up their reading and comprehension. Average students in a group performed several months' work in a month and a half.

Improvements in the use of microfilms are possible and probably require study and action. The use of motion pictures is in its infancy as a medium of education. Likewise, still pictures projected on screens appear frequently only at the college level. New facilities should probably be designed so as to permit the use of all of these mechanical facilities on a wider scale, even in secondary education. A matter of very great importance also is to be sure that new buildings contain the space and equipment where advanced students can pursue independent studies.

In all of this it is important that esthetic considerations be remembered at all times. No one knows the extent environment plays in the development of youth, but it is safe to say that young people brought up in an atmosphere of beauty are influenced deeply.

An important and ever-present factor is that of expense—how to get the most for the money. In this connection, it is particularly important to make the best use of existing facilities. Dr. Alvin C. Eurich, Vice President of the Fund for the Advancement of Education, reports that a governor of a state had before him a request for $42,000,000 for new buildings for institutions of higher learning, and wondered whether these institutions needed these buildings. The Fund financed an analysis of the use of buildings, which revealed that on the basis of an eight-hour day, five days a week, the classrooms in these institutions were used only forty per cent of the time. As a result, the governor obtained about the same total of money, but largely for the purpose of increasing faculty salaries and operations, rather than for additional classrooms.

Another area for exploration and action before building new facilities is the cooperative use of existing or new facilities among institutions located in the same geographical area. Bryn Mawr, Haverford, and Swarthmore have worked out a system for the joint use of their libraries, and have consolidated some of their classes. Such cooperative enterprises will avoid much expensive and unnecessary construction and may drastically influence the purpose and design of new construction at both colleges and secondary schools.

Of course, the costs of construction bear an important part in the Planning of Facilities. The Roman Catholic School system in the City of Philadelphia has a reputation for efficiency. In an archdiocese headed by a former President of Notre Dame University, and under the supervision of a priest learned in school construction problems, more than two hundred and fifty school construction projects have been undertaken in the last six years. These include more than one hundred new buildings and many extensions of existing buildings, as well as conversions. Typical of this construction is the Cardinal Dougherty High School for six thousand students. Statistics for this school are as follows:

Cubage	4,125,950 cubic feet
Total cost—excluding land, architect's fees and furnishings	$2,589,316.00
Cost per cubic foot	$ .6275
Cost per square foot	$ 10.75
Cost per student	$ 431.55
Cost per classroom	$ 21,240.00 [1]

The contract sum included considerable blacktop parking and drives, concrete sidewalks, copper piping, vitreous china fixtures, marble window sills, and toilet partitions.

[1] To cite an instance at the opposite extreme as to size, consider the following data for a five-room, transportable, parasitic addition to an elementary school in Newton, Massachusetts. The problem was to provide four or five additional classrooms for an existing 17-room elementary school located almost directly in the path of a proposed toll highway which, if built, would probably eliminate the need for the additional rooms. Therefore, it was deemed wise to create space that would be salvable by transporting it to another school if and when the school shrank back to normal size.

The design consisted of four regular pentagons—23′ to a side—clustered around a fifth space that serves as a lobby or commons room and which, under overflow conditions, can be used as a fifth teaching space. The classrooms were designed as pentagons because they could be clustered more compactly, thereby conserving site.

Cost of construction, exclusive of architect's fee	$62,500
Cost of furnishings and equipment	9,171
Total cost	$71,671
Cost per classroom under normal use	$17,920 equipped
Cost per classroom under maximum use	$14,334 equipped

The $21,000 cost per classroom figure is interesting, because in many schools paid for by the taxpayer, constructed of new and supposedly cheaper materials, the cost frequently runs about $50,000 per classroom. A question thus posed is: "What does a $50,000 classroom have that a $25,000 classroom does not have?" Some experts say the answer is all too frequently, "Nothing."

A prominent firm of architects and engineers specializing in school construction has this to say:

However, there are other factors, such as efficient planning, which must be considered. Very often the ratio of useable square footage is an important factor in planning. For example, classes cannot be taught in a corridor, yet corridors are necessary; however, consider the lower classroom cost of a building that is planned with a minimum of corridors per classroom over the cost per classroom of a building with a great deal of space devoted to corridors. There are other "whats" in the cost difference, too. We have seen steel and concrete skeleton frame schools on one-floor and two-floor plans. The steel skeleton construction was invented for skyscrapers, but has no place in the economy of a low rambling structure. We have seen schools where the skeleton could have been omitted entirely, and wall-bearing construction utilized at a tremendous savings. The same is true of patented flooring systems, patented roof systems, patented concrete systems, etc. Whenever the school administrators or architects fall for these patented or tricky systems, there is almost always sure to be an economic repercussion.

It is, of course, obvious that the excess money spent unwisely on unduly expensive facilities might well be available to increase teachers' salaries.

In my investigations into this subject, another wise school administrator told me that the most important aid to planning, now totally unavailable and much needed, was a sample budget for various kinds of buildings in different parts of the country. He wanted an authoritative answer, or at least a guide to such questions as: What should a high school for three hundred and fifty students contain, and how much should it cost? He points out that competition to have the biggest and best school with the biggest auditorium and the biggest gymnasium and the largest parking lot is extremely costly. His budget would cover such points as the proper size of all facilities and the appropriate approximate cost in relation to the number of students and the location of the school.

A college president wrote me he could obtain no really worth-while or well thought out advice as to the proper size of student bedrooms in his new dormitory.

A headmaster of a grade school wrote me that a survey made by him showed that many school sites remained inadequate for the programs expected of them and allowed little or no room for future expansion.

Not to be forgotten as a factor in the unnecessarily high cost of school buildings are the local building codes which, essential as they are, all too often add to construction costs without compensating benefits.

The problem now immediately before us is to decide which of these many new facilities are to be used in our schools and colleges. Fortunately for American education, the great private foundations, as well as many of our universities, are providing leadership in this field. For example, James B. Conant, President Emeritus of Harvard, is devoting full time for two years to a study of the American Public Comprehensive High School, Its Strengths and Weaknesses. In his report he will make recommendations concerning high schools of the future. This study is financed by the Carnegie Corporation.

Within the last few months, the Ford Foundation has created a new, independent, non-profit corporation, with an initial appropriation of 4.5 million dollars, to be known as the Educational Facilities Laboratories, Inc. This organization is to be concerned with research and experimentation leading to improvements in the construction of school and college buildings. The new agency will also serve as an information clearing-house. Its data on school design, building, and equipment will be available to architects, local school systems, college trustees, and others involved in the nationwide expansion of educational facilities anticipated throughout the country.

For purposes of cost comparison, the following hourly wage rates obtained at the time of construction in 1954:

Bricklayers	$3.085
Common laborers	2.07
Carpenters	2.75
Painters	2.35
Plumbers, electricians, steamfitters	3.00
Sheet-metal workers	2.85

Charged against the project, and included above, were abnormal costs of connecting to the main building—amounting to approximately $4,000.

Testimony of teachers using the space is that this small, transportable, parasitic addition provides the best educational space that has been constructed in a program of approximately 200 classrooms built in the Newton Schools since World War II.

Educational Facilities Laboratories will also support several cooperating experimental centers that will serve as research laboratories and demonstrations of efficient construction and furnishing of educational facilities. The projects may be in elementary and secondary schools, colleges and universities, both public and private. In order to be useful in the training of teachers and school administrators, cooperating experimental centers will be related in most cases to a university or teacher-training institution. Selected experimental projects will be granted research costs over and above regular construction and operational costs. The organization will coordinate the efforts of industrial and educational officials, architects, designers, and others concerned with better school buildings and equipment. It will not engage in testing or approval of materials. This organization, it is hoped, will be able to provide some leadership in the field of research and planning of facilities.

Another reason why such leadership is needed is that some strange ideas are being expressed. The views of some ultra-extremists would seem to be as dangerous to our future, as those of the ultra-conservatives. A news article, containing the following points, among others, went out over the A.P. news wires on February 26, 1958:

Even Books May Go!

TV to Revolutionize Schools?

ST. LOUIS—Television in the classroom soon will be the most dominant force in American education. Entire schools will be remodeled or rebuilt because of it.

In a convention meeting of the American Association of School Administrators, Philip Lewis of the Chicago Board of Education drew this picture of the shape of things to come:

"There may be no need for costly auditoriums and assembly halls. Closed-circuit television can bring together, electronically, all the pupils of a school.

"Libraries of the future will incorporate television techniques to eliminate books as we know them today.

"Closed-circuit television will eliminate the need for costly spectator space in gymnasiums, swimming pools, etc. The athletic events can be piped directly into the classrooms."

Perhaps I am ultra-conservative, but I want to say that I do not expect to see the day of the library without books, the school football game piped into the classroom, and the mind trained without thinking, merely by looking at pictures on television.

CONCLUSION

The proposed expenditure of forty billion dollars in the next ten years for the construction and improvement of educational facilities is a matter of the utmost importance in American education, and will undoubtedly influence the character and trends of American education for many years to come. Under these circumstances, it is essential that this program be based upon adequate research and planning. This planning should be carried out in the American manner, involving free discussion and free decisions. All decisions should be based on an understanding of the purposes of American education, a knowledge of curricula and complete facts as to types of existing facilities, facilities now under construction and facilities to be considered for the future in all parts of the country.

Full, but common sense use must be made of television, sound recordings, motion pictures, tapes for remedial reading, microfilming, electronic equipment, and other new equipment of all kinds.

In this connection, education is in as much danger from the ultra-extremists as from the ultra-conservatives. Those who suggest that in the library of the future books may be eliminated as we know them today, and that high school athletic contests will be viewed on closed television by students sitting at their desks, are probably as harmful to the future development of young people as those conservatives who will have nothing of new techniques.

Nevertheless, the schools of the future will probably be a different shape and contain many different sized and some adjustable rooms and much new equipment as compared with the schools of today.

Esthetic considerations should still remain of high importance. The influence of beauty upon the growth of youth must not be forgotten.

It is quite possible that the use of new facilities and devices may well be the means of increasing teachers' salaries substantially by enabling teachers as a group to educate more pupils, and at the same time to give those pupils who need it more personal attention.

Cost of school buildings must be controlled. We must have the most for our money. Some experts tell us that the $50,000 classroom of today has nothing of real value to the student above the $25,000 classroom. Yet in all too many areas, the $50,000 classroom is what the taxpayers pay for.

Sample budgets must be prepared for general study.

Local Building Codes must be revised to permit the use of new designs and new materials and to help reduce over-all costs. Uniform building codes should be drafted by experts for different sections of the country to meet different weather conditions.

Better use of existing facilities is also of great importance. Today, most educational facilities are in use only forty per cent of an eight-hour day on a yearly basis. Cooperative use between colleges and schools of their facilities, old and new, such as presently in effect at Bryn Mawr, Haverford, and Swarthmore, should be explored if costs are to be kept within bounds. All of this requires careful research and planning at all levels. It is heartening to see that our great private foundations are taking some leadership in this field. Their studies and reports, particularly those of the Ford Foundation through its newly formed Educational Facilities Laboratories, should be watched for by everyone interested in this subject. I hope that the American Philosophical Society, through its meetings, research, and other programs, will take an active and not a passive part in solving these problems so important to our national welfare.

THE MECHANISM OF FROST HEAVING OF TREE SEEDLINGS

J. R. SCHRAMM

Professor Emeritus of Botany, University of Pennsylvania; Research Scholar, Indiana University

INTRODUCTION

THAT destructive soil heaving is not due significantly to the expansion of soil water on freezing *in situ* in the soil interstices but to the freezing of water progressively segregated from the soil, has been known for a long time. And the relation of this established fact to the mechanism of frost heaving of plants has, at least in a general way, been understood in certain quarters for many years. With the former, geologists and engineers especially are well acquainted. The importance of soil frost phenomena in railroad, highway, and airport construction has stimulated much research, as has the recent marked increase of interest in the arctic regions. But with the latter, i.e., the precise mechanism of frost heaving of plants, botanists—including many ecologists and foresters—appear on the whole to have little acquaintance. This is the more surprising since botanists (von Mohl, 1860; Sachs, 1860) made important contributions fundamental to an understanding of the process; and half a century later a forester (Hesselman, 1907) applied this theoretical knowledge in correctly explaining the heaving of tree seedlings. In the light of the foregoing there is an obligation to offer some justification for the present paper.

For some years the writer has carried on plant colonization studies on black wastes from anthracite mining operations.[1] On one type of these wastes (culm or "slush") frost heaving of tree seedlings occurs under certain conditions—in the same manner as on some soils, but on a scale so exaggerated as to offer unusual opportunity for studying the phenomenon. The nature of the culm and the magnitude of the heaves are such that the process is revealed with striking clarity. It is hoped that the present report will in some measure convey this clarity and acquaint a larger circle of plant workers with the mechanism of the important and widely occurring phenomenon of frost heaving of plants.

A second reason for this paper is that it may shed light on the specific mechanism whereby transplants and older seedlings of evergreen conifers, as contrasted with young seedlings, escape heaving to a greater or lesser extent. Forestry literature is replete with reports of striking differences between heaving damage to young conifer seedlings versus older seedlings and transplants. The explanations offered for these differences are in nearly all cases general and not particularly satisfying. In the studies here reported the immunity to heaving on culm is one hundred per cent in pine transplants and zero in one-year seedlings. Since the exact mechanism whereby this immunity is achieved became clear during the studies, it is recorded here in order that its significance, if any, may be explored in natural substrata, including nursery and forest soils.

OBSERVATIONS

In processing anthracite, the fine material is removed by washing. The suspended matter, consisting mainly of coal and ranging from very fine material to particles of larger size, is conveyed to natural or artificial basins to settle out. When operations are discontinued, the surface dries. Familiar and distressing are the black dust clouds swept up from these culm banks.

Pronounced heaving of seedlings on such banks occurs, so far as observed, only when the culm is (*a*) wet to the surface and (*b*) initially completely free of frost. If mild freezing temperatures then set in such that the water in only a thin surface layer of culm freezes *in situ*, additional water moves against gravity from below and in turn freezes. The latter water is not water frozen in the culm interstices as is that in the surface crust. Instead, it is water "segregated" (Taber, 1918*b*) from the culm and frozen as relatively pure ice, the culm below this ice stratum remaining unfrozen. But this segregated water does not

[1] The observations to be reported were made on the disused culm bank of the former Silver Creek Colliery of the Philadelphia and Reading Coal and Iron Company, near New Philadelphia, Pennsylvania. The author is indebted to the Company for courtesies and assistance in many ways.

The interest and support of the late Colonel Edwin M. Chance of Philadelphia are also gratefully recorded.

freeze as a solid layer of ice underlying the frozen surface crust of ice-culm mixture. Instead, it takes the form of ice filaments grouped in columns arranged vertically to the surface, i.e., vertical to the cooling surface. It should be noted, too, as has Hay (1936), that the columns or groups of columns are more or less discontinuous laterally, i.e., there are vertical voids between them (*cf.* Woodd Smith's excellent description, 1884). Also, the ice columns contain air cavities (Sachs, 1860; von Mohl, 1860; Taber, 1930*a*; etc.), rendering them porous. On 900 sq. cm. experimental areas, Fukuda (1936) measured the height of the ice column layer which developed over night in the open, and determined the total weight of the columns on each area. Taking as 100 the space occupied by the ice column layer (product of the area by the height of the columns), he found that the actual ice occupied on the average only 7.06 per cent of this space, though the columns gave every appearance of being closely ranked. He cites data from a paper in Japanese by Goto and Inagaki (1897) who report corresponding values of 30 and 15 on very dense and loose soils, respectively. These facts are important, because for a given volume of segregated water a very much greater heave of the surface is achieved than if the same volume of segregated water froze as a solid ice stratum.

Thus are initiated more or less closely ranked vertical columns of ice which grow at their bases, and at their apices merge into the frozen surface crust of ice-culm mixture. As they grow the crust is pushed upward. Though the surface before freezing was level and smooth, the frozen elevated crust (fig. 2) was often fissured. Yet all, or nearly all, of the original surface was raised by the ice columns, though to different heights, probably because of highly localized differences in culm texture and therefore in the size of the interspaces. The resultant influence on water movement would affect the amount of growth of the ice columns.

When the ice in the crust and in the columns melts, the surface settles back to nearly its original level, with, however, much of the configuration of the elevated frozen condition temporarily retained. The process may be repeated night after night if moisture and temperature conditions are favorable. In fall and spring when there is no frost in the culm but mildly frosty nights follow frostless days, conditions are favorable for the process provided at the same time the culm is wet to the surface so that movement of "soil" water to the base of the ice columns forming near the surface can take place readily. Heaves of three or four inches in a single night are not uncommon at such times.

FIG. 1. Partial profile of basally growing ice columns pushing up frozen surface layer of culm in heaving process.

A profile of such heaves is shown in figure 1. Many of the ice columns are much flattened, predominantly in the same direction, giving the appearance of long incisor teeth. The reason for this was not explored. It is suspected, however, that it is related in some way to wind assortment of culm particles since the flat faces of the columns are oriented fairly consistently parallel to the prevailing northwest-southeast wind (the Silver Creek culm bank is subject to strong blowing in

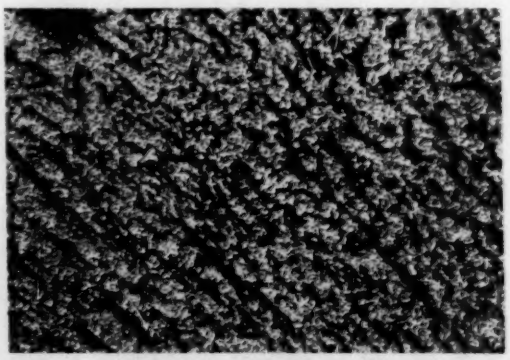

FIG. 2. Frost-heaved culm surface. The photograph, taken perpendicular to the surface, shows the surface in normal compass orientation. The anastomosing ridges and furrows are oriented parallel with the strong prevailing northwest-southeast winds.

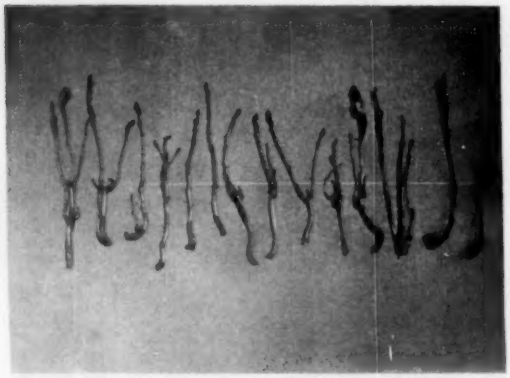

FIG. 3. Epicotyledonary portion of one-year red oak seedlings, severed just above cotyledonary node by frost heaving, leaving cotyledons and root in the culm. Position of culm surface with respect to seedling stems is indicated by white line. (Branching of shoots at or below surface is due to heat-killing of initial and often later shoots, followed by new shoots arising from subsurface uninjured nodes. High radiant energy absorption by the black material generates lethal temperatures in shallow surface culm layer.) See also figure 4.

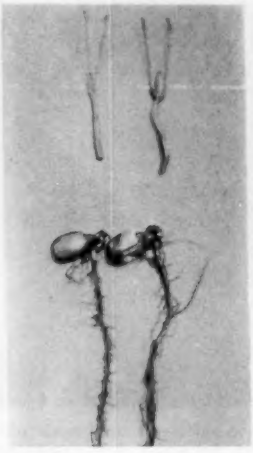

FIG. 4. Red oak seedlings severed just above cotyledonary node by frost heaving. In both cases the lower segment was excavated and placed in relation to the corresponding heaved upper one. Position of culm surface relative to the stems is indicated by white line. See also figure 3.

this direction). It will be noted, too, that the fissures in the frozen raised crust (fig. 2) present a pattern of northwest-southeast orientation, also suggesting that the fissures and ridges (regions of shorter and longer ice columns respectively), which develop during the heaving, are related somehow to wind assortment and deposition of particles, with consequent very local differences in the size of voids and corresponding effects on the dynamics of water movement.

In the light of these phenomena the mechanics of the heaving of seedlings is at once apparent. As the surface of the wet culm freezes, the seedling shoots become firmly encased in it, thus enabling the elongating ice columns immediately below to exert an upward thrust on the seedlings (*cf.* Krumme's account, 1935, of heaving of stakes driven into soil). As a result the seedlings, rooted in completely unfrozen culm, are either pulled upward or, if rooted too firmly, are torn in two (figs. 3 and 4). The process is analogous to clamping on the shoot at the soil line a collar against which upward pressure can be exerted until the larger roots are pulled loose or, if they hold, the stem is severed. Bark slippage under this upward thrust, as reported by Haasis (1923) and Tryon (1943), did not occur.

In this way smaller seedlings such as one-year pines may be lifted out in one night. To an observer arriving on the scene early the next morning, such pine seedlings appear normal (fig. 5); but when thawing begins and the heaved surface layer which held the seedlings fast lets go and settles back to approximately its initial level, the plants topple over and lie prostrate on the surface (fig. 6). Stout seedlings with deep tap roots, like oak, require several liftings (unless they

FIG. 5. Heaved one-year pine seedling photographed early in the morning. The seedling was completely heaved out the preceding night, but appears in normal position because thawing has not yet begun. Note small amount of culm splashed on the stem by moderate rain preceding freezing to form a small "splash cone."

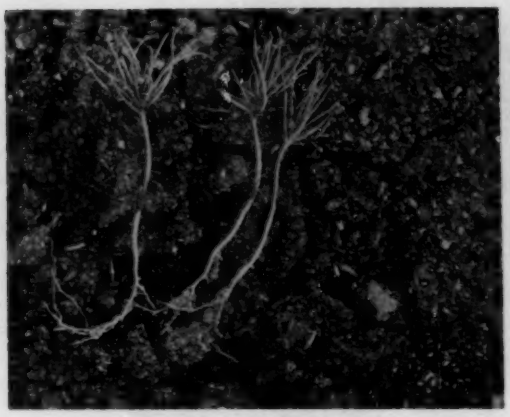

FIG. 6. One-year pine seedlings heaved out in one night. Thawing of the Kammeis responsible for the heave leaves the seedlings prostrate. Note the left-hand seedling where caked fragment of the crust, now thawed, still adheres to the mid-section of the stem. Splash cones were not involved, the shallow frozen surface layer constituting the sole grip on the stems.

are severed—see below), representing successive hitches lower and lower on the stem and then on the tap root in repeated heavings; meanwhile the seedlings remain erect. In due time oak seedlings with tap roots fifteen and more inches long are pulled out completely and lie flat on the surface (fig. 7). The fate of the less robust seedlings of persimmon is similar (fig. 8).

When to the above factors one other was added, seedling injury in its most dramatic form was observed. This additional factor is hard rain, which

FIG. 7. One-year oak seedlings prostrate on the surface after repeated frost-heavings. These seedlings were not severed, and in most instances the cotyledons still in the seed coat were pulled out intact and attached.

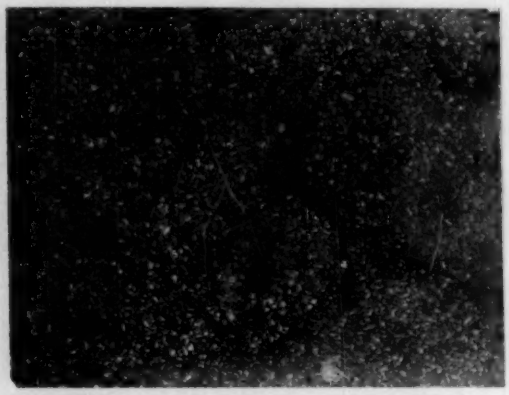

FIG. 8. One-year persimmon seedlings lying flat on the surface as a result of repeated heavings.

splashes surface culm particles on the stems. The particles adhere to the stems and, in small evergreen conifer seedlings, also to the needle mass. In this manner a cone of wet culm is built up with its base on the surface (fig. 9). If mild freezing temperatures follow promptly, these cones lose heat rapidly and freeze tightly about the seedlings. Thus there is provided a very substantial collar with large basal area and vertically more extensively anchored to the stem than is the shallow horizontal layer which freezes around the stem to form the whole of the grip when no "splash cones" develop. Since hard rains produce such cones, favorable moisture conditions invariably ac-

FIG. 9. A heaved one-year oak seedling with massive splash cone gripping base of stem. Apex of cone extends up to point where the two shoots appear to diverge, widening below until the broad base of the cone merges with the culm surface.

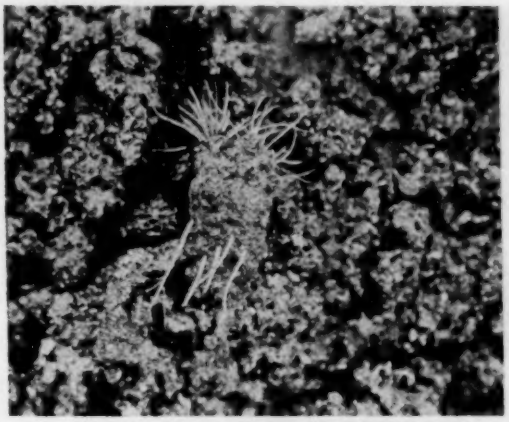

FIG. 10. One-year pine seedlings heaved out in one night and now prostrate on the surface following thawing. Though now thawed, the massive splash cone which gripped the seedling group, including needle tufts, still clings to the prostrate seedlings. The photograph, made at an angle, shows the under side of the caked cone with the stems projecting through it. Note that the four seedlings on the right were severed at about the transition between root and stem. In the left-hand seedling the major roots were torn.

company presence of cones. If suitable freezing temperatures follow promptly, the stage is set for spectacular injury.

In a single fall night when these ideal conditions prevailed, rows of oak seedlings of the preceding spring were raised three and four inches, or in many cases were severed at or just above the cotyledonary node [2] some inches below the surface (figs. 3 and 4). Red oak seedlings a year old are stout and woody. That they should be severed by a linear pull testifies both to the extensive development of anchoring root systems in the culm and to the impressive upward thrust exerted on the collar by the basally meristematic ice columns.

As melting occurs, more or less of the cone usually continues to adhere to the seedling. In current season pine seedlings pulled out in one lift this was true even after they toppled over (fig. 10). In seedlings with longer underground axes (e.g., oak), a portion of which remains in the soil so that the plant continues erect after the heaved culm surface returns to its normal level as a result of thawing, these cones may also persist temporarily. But now their truncated bases occupy a position above the general surface by a distance equal to the vertical extent of the heaving (height of ice columns) which took place, the ice columns responsible for the lift having meanwhile melted. A photographic record of such seedlings was not made. Figure 11 shows the same phenomenon as observed simultaneously on heaved marker stakes nearby, although in this case the cones were exceptionally slender.

By late October all seedlings (persimmon (*Diospyros virginiana*), pine (*Pinus virginiana* and *P. rigida*), and oak (*Quercus alba, Q. borealis,* and *Q. bicolor*)) from the spring seeding had been severed or pulled out in the manner just detailed. But in some four hundred pine transplants [3] (*Pinus banksiana, P. strobus, P. sylvestris,* and *P. rigida*) of various ages planted out nearby on the same culm bank in the same spring, not one showed evidence of heaving or heaving injury. This has continued to be true, not only of these transplants but of hundreds planted on the site subsequently. That pine transplants escape this injury so devastating to seedlings, deciduous and evergreen alike,

FIG. 11. Marker stakes with caked remnants of slender splash cones adhering, heaved four inches in one night. The space between the truncated bases of the elevated cones and the present surface of the culm was occupied by the four-inch ice columns (now thawed) responsible for the heave. So far as could be determined, the stakes did not settle back appreciably into their sockets when thawing returned the culm surface approximately to its original level. Note that the ridges of the heaved surface usually remain after the culm surface returns to its initial level.

[2] Since the break invariably occurred at this point, to a linear pull the latter is evidently structurally the weakest region of the axis below ground level. Perhaps the crook in the axis at this point contributes to the weakness.

[3] Kindly supplied by the late Mr. D. C. Lefevre of the Clearfield Bituminous Corporation nurseries.

was puzzling and obviously significant and of practical importance.

It was at first suspected that the transplants were stouter and more firmly rooted—the explanation most often encountered in forestry literature for the greater heaving of young evergreen seedlings versus transplants and older seedlings. Some of the pine transplants, however, were no larger in stem diameter than the better oak seedlings. And in firmness of rooting the oak seedlings usually excelled, though without thereby achieving any immunity. It was ascertained, too, that the adjoining transplant and seedling areas were equally subject to heaving. Since pine stems are rougher (former needle attachments), the collar frozen around the stem might be expected to be even less likely to slip under upward thrust than on the smoother stems of oak and persimmon. This should make for greater heaving in pine transplants.

The explanation proved to be surprisingly simple. Pine transplants, being evergreen, present at all times considerable surface. Even very gentle air currents sway them more or less. By this motion the woody and relatively stiff stem exerts lateral pressure on the culm. Inasmuch as destructive heaving occurs only when the culm is initially unfrozen and wet to the surface, the culm is displaced laterally by the swaying stem and, because it is wet, does not cave in when the pressure is relaxed. In this way the stem works itself completely loose from the culm (fig. 12). The radial extent of the free space surrounding the stem (greatest at the surface because the swaying stem, pivoting somewhere below the surface, here describes the greatest arc) is very variable. Its dimension depends on velocity of air currents, resistance area presented to the wind by the above-ground portion of transplants, ease with which the stem is swayed as a result of depth of planting and firmness of root anchorage, resistance of the surrounding culm, etc. It may be under an eighth of an inch; yet, as will be seen presently, this is sufficient to confer immunity. If now the culm surface freezes, what was described earlier in the seedlings as a collar tightly gripping the stem, is in the pine transplants a frozen ring free from the stem. Thus, when ice columns form and push upward the frozen surface crust, the ring moves harmlessly up the stem, leaving the transplant undisturbed (fig. 13).

FIG. 12. Annular free space about the stem of a pine transpant produced through lateral pressure on the moist unfrozen culm by the swaying stem. Note the absence of ridges on the frost-free surface.

FIG. 13. Heaved culm surface about a pine transplant. Note the free annular space around the stem, formed before freezing and heaving started (see fig. 12). As a result the crust does not grip the stem. As freezing and heaving occur, the crust moves harmlessly up the stem, leaving the transplant undisturbed. Note deeply ridged crust.

Deciduous seedlings like oak are stiff and, at heaving seasons, bare, presenting little surface. Very strong winds would be required to sway them sufficiently to free the stems even minutely from the wet culm. No such free annular space was ever observed around oak or even the less rigid persimmon seedlings. In living pine transplants, on the other hand, very gentle air movements suffice; apparently these are always present at such times, at least on the Silver Creek culm bank. In observations on successive lots of young pine transplants over a period of years no heaving injury has occurred, and the "free ring" was noted on all occasions. Strong corroborative evidence is provided by the transplants them-

selves, for very different was the fate of those which died and shed their needles. No longer presenting a large surface, they too now require stronger air currents to free the stems from the wet culm. As currents of requisite velocity do not dependably accompany heaving conditions, it is not surprising that such dead and bare pine transplants heaved almost as commonly as did deciduous seedlings. No oak or other deciduous transplants were at hand for comparative observation. But there appears no reason to doubt that their fate on culm is accurately predictable from the behavior of the denuded pine transplants.

It remains to comment on the difference in behavior of first-year pine seedlings versus pine transplants. At the end of the first growing season pine seedlings are thin-stemmed and very flexible; and the needle tuft is close to the soil surface, where incidentally velocity of air currents is reduced. When such seedlings bend under wind stress the stems are so pliable that not sufficient lateral pressure is exerted to displace the wet culm and free the stems: the bending occurs above the soil surface. In consequence, when freezing occurs the seedling stems become tightly gripped by the frozen surface crust. Given requisite moisture conditions and temperature gradients, seedlings so situated, as noted above, are heaved out completely in one night (figs. 6 and 10).

As mentioned earlier, the thrust of the basally growing ice columns which lifts or severs one-year oak seedlings is obviously substantial. In laboratory experiments on cylinders of clay in contact with water at the lower end (open system) and cooled from above, Taber (1930*a*) obtained heaving pressures from growing ice columns of up to nearly 12 kgm. per sq. cm. Effectively to exert this thrust upward on the under side of the frozen crust gripping the seedlings, the ice columns must rest on a relatively unyielding base. Such a compact base was indeed present at the base of the ice columns about a heaved or severed oak seedling. With care this moist and unfrozen foundation is easily and neatly separated from the lower end of the ice columns,[4] revealing on its upper surface (the ice column-generating region) the pressure imprints of the bases of the clusters of ice columns (fig. 14). The ice-generating layer owes its firmness to the natural consistency of the fine-grained stratum. But that some packing of its surface results from the thrust of the ice columns in lifting or severing oak seedlings is indicated by the following fact. When ice columns were similarly separated from the unfrozen generating stratum in areas free of seedlings (where the columns merely pushed up the thin frozen surface crust), the irregular angular imprints on the generating niveau were absent. Troll (1944) reports that in the high mountains of South Africa where conspicuous columnar ice development occurs diurnally, lifting only a very thin surface crust, the unfrozen generating level is absolutely smooth and level ("butterbrotglatt"). Hesselman (1907) likewise found the unfrozen segregation level in drained peat bogs in Sweden completely even. Many others record the same fact.

FIG. 14. Vertical view of the water-segregating level of the subsurface fine-grained layer where the ice columns are generated. The fragment photographed (in center of figure and roughly square) immediately adjoined a heaved oak seedling. Note the irregular angular imprints made by the thrust of groups of ice columns. Note also the clay-like character of the generating stratum in contrast to the coarse-grained surface layer (the coarse particles at upper left and lower right corners of the fragment were inadvertently dislodged from the surface).

It is apparent that in heaves of as much as four inches in a single night, actually not over one-half inch of culm was heaved—the surface layer. All the rest of the heave consisted of porous needle ice formed from water supplied from the unfrozen culm below, the latter not disturbed in its position in any way. And this heaved surface layer is also the only part of the heave which is actually frozen culm, i.e., with the water frozen *in situ* in the culm voids. Since this surface layer is thus

[4] Growing ice fibrils are not frozen to the generating substrate; indispensible for their growth is the presence of a film, however thin, of liquid water between the base of the fibril and the immediately subjacent soil particle or particles.

the only component of the entire heave complex in which the expansion of *in situ* water on freezing contributes to the total heave, it is of interest to calculate the approximate magnitude of this contribution. According to Taber (1929) the water content of an average soil is seldom as much as 50 per cent. It is doubtful whether it approached this figure in the culm, especially in the coarse-grained and easily drained surface layer which forms the crust. But it will be assumed that the water content was 50 per cent and that the crust was one-half inch thick. With water increasing roughly 10 per cent in volume on freezing, and assuming that all this expansion is exerted vertically upward, the frozen layer would have registered a maximum vertical elevation of 1.27 mm. In a total heave of four inches, this contribution is thus 1.25 per cent (1.66 per cent in a three-inch heave), leaving over 98 per cent to be accounted for by the columnar ice formed from water segregated from the unfrozen culm beneath. Here may be recalled the immunity to heaving of the pine transplants. The soil about the transplants underwent as much freezing as that about the seedlings. That the former were undisturbed but the latter heaved out in one night, dramatizes the negligible role in heaving played by the expansion of water in freezing *in situ* in culm.

The essential morphology of a soil in the act of heaving plantlets (or other objects projecting through the surface) comprises a relatively thin surface ice-soil crust pushed up by immediately subjacent vertical ice columns, the latter growing at their bases resting on unfrozen soil. For this structural entity, in which the component crust and columns are equally essential, there is not, so far as the author is aware, a satisfactory recognized English term. Taber's "needle ice" (1918*a*) is admirably descriptive of the segregated ice component; but the term does not, and was not intended to, suggest the inclusion of the ice-soil crust.

The Old World literature contains a number of terms—adopted from the vernacular—such as the Finnish "Rouste," the Swedish "Pipkrake," the German "Kammeis," etc.; also the Japanese "Shimobashira" (Wagener, 1877). Of these, "Kammeis" (comb-ice) appears, as it did to von Mohl a century ago, peculiarly apt and descriptive, with the back of the comb represented by the crust and the subtended teeth by the ice columns. Von Mohl's comment on the term (1860) merits quoting:

> Dieser Ausdruk [Kammeis] ist vortrefflich, indem die dünne durch das Eis in die Höhe gehobene oberflächlich liegende und gefrorene Erdschichte gar nicht übel dem in der Technologie sogenannten Felde (d.h. dem Theile, von welchem die Zähne ausgehen) des Kammes und die Eisnadeln den Zähnen desselben entsprechen.

The suggestion is ventured that "Kammeis," in the sense used by von Mohl, be used to designate the morphological entity under consideration, avoiding a rendering into English; for the latter ample precedent exists.

In making this suggestion the author is aware that probably in most cases in which the term has been and is being used it is synonymous with needle ice, i.e., does not include the surface ice-soil component. Confusion would be avoided if "Nadeleis" or "needle ice" were used to designate columnar ice formed from segregated water, restricting "Kammeis" to the composite morphological entity involved in frost heaving of plants and other objects projecting into or through the surface crust. Troll (1944) suggested "Borsteneis" (brush ice) as even more descriptive than "Kammeis" because the ice columns are analogous to the bristle tufts of a brush in that they are composed of bundles of ice filaments. Apt as is this analogy, the term again applies only to the columnar ice and does not include both components of the integrated structure involved in plant heaving.

DISCUSSION

Culm surfaces dry rapidly, the high absorption of radiant energy by the black material being an important factor. Thus, black dust clouds may be whipped up by the wind within an hour after a drenching rain. But the thin dry surface layer formed acts as a mulch progressively retarding further and deeper drying. In observations covering several years the line of obvious free moisture was never noted more than two or three inches below the surface, even during summer droughts.

With winds carrying off the very fine material, the heavier coarser particles are left behind as the major components of a shallow surface layer (*ca.* one-half inch). Only this shallow layer froze under the conditions when seedling heaving occurred. This stratum, having little very fine material, probably freezes at or very nearly at 0° C., the water being in large voids and its freezing point therefore not appreciably depressed. It was below this coarse-grained layer, where fine material definitely predominated, that water seg-

regation took place and the vertical ice columns were generated which raised the surface crust with its water frozen in the large voids.

As noted, figure 14 shows a surface view of the exact ice column-generating layer (always unfrozen so long as it acts as the generating layer). No mechanical analyses of grain size were made, but it is apparent from the photograph that this layer is composed predominantly of very fine-grained material as contrasted with the surrounding coarse-grained culm of the surface layer which freezes. Beginning at the generating level the culm is almost clay-like in consistency whereas that of the thin layer above which freezes to form the surface crust is sand-like.

The important question arises: what interplay of factors determines the precise level at which, in any given set of circumstances resulting in heaving, water segregation and ice column formation are initiated; or put in another way, what determines the level at which frost penetration stops and water segregation and column formation begin? The problem centers first of all in the physical-chemical properties of water and the interfacial relations of water with the soil particles—a water-soil system. Complicated by the involved array of variables presented by soils, the question raised is obviously complex—one which is outside the competence of the author to treat at the theoretical level. For the purposes of the present paper, however, some approximation to an answer may aid in envisaging the heaving process. In making the attempt, the writer is aware that his is a limited familiarity with the voluminous and widely scattered literature.

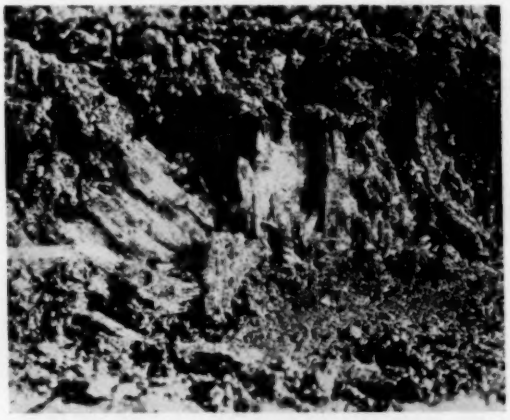

FIG. 15. Profile of Kammeis showing the homogeneously frozen crust pushed up by the subjacent vertical columns of pure ice (needle ice). Columns on the left have partly fallen over as a result of onset of thawing.

The drastic heaves, which by early fall had destroyed every experimental seedling on the Silver Creek culm bank, all occurred when the night temperatures dropped only very moderately below the freezing point. Temperature records at the site were not obtained. In Pottsville, Pennsylvania, five miles away, the official temperatures on the nights in question were only slightly below freezing. Three other facts suggest that the temperatures could have been only a little below the freezing point. (1) Though the black culm loses heat very rapidly, only a thin (not over one-half inch) surface layer froze, i.e., the water frozen *in situ* in the large voids in the coarse-grained surface material. (2) On the October mornings following the spectacular heaves, melting began with the first rays of sunshine. The photograph reproduced in figure 15 and representing a profile of the crust and subjacent ice columns was made at sunrise. Before camera focusing could be completed, melting had set in as evidenced by the partial toppling over of the columns on the left side of the photograph, which occurred just before the exposure could be made (*cf.* Mohaupt, 1932). Very soon such collapses became general along the profiles cut, lending an aspect of animation to the scene. (3) On the early morning following the night of the most spectacular heaving, there were scattered very local patches where the ice columns were not topped by a frozen crust, i.e., the columns arose at or very near the surface of the culm (fig. 16), apparently no culm surface being raised. In these local areas, therefore, frost had for all practical purposes not penetrated at all, though ice columns two inches or more high had formed. Thus the stratum generating the ice columns was essentially the surface of the culm. Such a state of affairs could hardly come about except with air temperatures but little below freezing.

It is regrettable that the nature of the culm in these local patches was not more carefully examined, still more that no analyses were secured of the grain sizes of these areas and of those of the large expanses characterized by a surface crust raised by subsurface ice columns. The surface of some of the areas in which free-standing ice columns appeared had been disturbed very recently in the course of the experimental work. This obviously was the case in the area represented in

FIG. 16. Free-standing ice columns generated approximately at the culm surface. Arrow indicates position of a palisade of ice columns (8 columns visible) which have pushed up a continuous but very thin frozen crust.

figure 16. Though the writer cannot be certain that the phenomenon was confined to disturbed areas, the possibility suggests itself that the disturbances had exposed local irregular patches of the subsurface fine-grained culm. With very gentle temperature gradients between air and this material, the freezing point depression of the water in the small voids of the latter might have sufficed to arrest frost penetration almost at once and long enough for water segregation and ice column formation to begin—virtually at the surface. Actually, at the tips of some of the columns in figure 16 binocular examination reveals a very small mass of culm. And in at least one instance (arrow in fig. 16) the masses are appreciable and joined laterally so that the palisade of some eight ice columns terminates in a common horizontal and continuous surface crust of frozen culm. Thus, it is probably more correct to say that in these patches frost penetrated the surface before water segregation and ice column formation began, though to so negligible a depth that only rarely and very locally was a continuous frozen crust formed—and then only a very thin one. The great majority of ice columns were separate, at most topped by a tiny frozen culm cap, and free-standing, like the "ice flowers" reported so frequently, especially in the older literature, as arising under similar conditions of temperature and moisture from dead plant parts or from ground surfaces (Herschel, 1833; LeConte, 1850; Caspary, 1854; Coblentz, 1914; etc.).[5]

As noted, the freezing point of the water in the large interspaces of the surface layer is not depressed appreciably. On the other hand, at least some of the water in the small voids in the subjacent clay-like culm is subjected to greater stresses with consequent depression of its freezing point. (This is a stable condition and is not to be confused with supercooling, an unstable condition with which we are not here concerned (Dorsey, 1948).) An air temperature at or only very slightly below freezing suffices to freeze the water in the large interspaces of the surface layer, giving rise to the crust. When the advancing frost line reaches the clay-like culm, it encounters water with a freezing point slightly lower (depressed). If the temperature gradient between air and soil is very gentle, this differential may suffice to halt frost penetration and allow time for water to move from the unfrozen culm below to the base of the ice already formed and there enter the ice phase. That is to say, the temperature at the base of growing ice columns is appreciably below the freezing point. In two series of laboratory tests on soft clay soils (U.S.A. Corps of Engineers, 1949) temperatures at the base of ice lens formation were 28.4–30.2° F. and 30.7–31.1° F., respectively. MacKintosh (1936), in laboratory tests of clay soils in cylinders undergoing freezing, reports that the 32° F. line was 2½ inches below the lower limit of ice formation.

Since water as ice has less free energy than liquid water, the ice already present may roughly be thought of as acting as a "sink" for free water molecules from below to move to the region between the base of the ice filaments and the immediately subjacent soil particles and there be added as ice to the base of the filaments.[6] This process obviously can go on at any given level only so long as frost does not penetrate more deeply to freeze *in situ* the water in the voids of the unfrozen stratum where the water segregation is taking place; also, only so long as there is

[5] Though no seedlings were present in any area displaying free-standing ice columns, it is safe to assume that no heaving injury would have befallen them. Not being gripped by a surface crust of frozen culm, the elongating ice columns would be powerless to exert an upward thrust on the plantlets.

[6] No attempt will be made to deal with the question of the precise forces involved in and responsible for this movement of soil water. But whatever the nature and contribution of these forces (e.g., whether the water molecules are pulled into the film between the base of a growing ice fibril and the subjacent soil particles or reach it through the action of other forces), it is the forcible entry of water molecules into the film, which is constantly being attenuated by congelation, which directly and primarily accounts for the heaving force.

abundant water below so that the films of water moving to the "energy sink" at the base of the ice filaments are not interrupted.

Since, in the several heaves which destroyed all experimental seedlings on the culm bank by early fall, neither storied needle ice nor stratified frozen culm (see below) were ever encountered, it follows that all the water segregation which effected a heave of three to four inches in a single night occurred at one and the same level. This is to say that, once frost penetration was arrested and water segregation initiated at a given level, the latter continued to be the ice column-generating niveau throughout a given heave. Frost penetration, once arrested, was not resumed. This fact likewise emphasizes that freezing temperatures representing only a very moderate gradient between air and culm, other conditions being favorable, are conducive to the most destructive heaves.

Since the passage of water from the liquid to the solid phase is accompanied by a substantial release of energy as heat, this heat—and that of the relatively warm water moving from below to feed the growing ice fibrils—are important factors in the maintenance of the frost line at a given level once frost penetration has been halted long enough for water segregation and ice column formation to be initiated. And though ice is a much better conductor of heat than is water (Patten, 1909), the ice-column stratum is so porous (see above) that it has an insulating effect similar to that of snow (Krumme, 1935) in retarding loss of heat from the substrate, likewise tending to retard frost penetration to deeper levels. Thus, once a water-segregating and ice fibril-forming level has been established, it tends to perpetuate itself, and indeed does so if heat supply and heat loss continue to be essentially in balance at the segregating level—always assuming that water supply is adequate.

If on the other hand the temperature gradient between air and soil is very steep, frost penetration is so rapid that no water segregating- and ice column-generating zone can be established. In these circumstances the soil freezes homogeneously (Jung, 1932; Taber, 1929; Beskow, 1935). The slight heaving at such times is limited to the volume change (roughly one-tenth) of the water as it passes from the liquid to the solid phase. Such heaving is of little or no consequence to plants, at least outside the arctic and colder temperate regions.

If, finally, the air-soil gradient is less steep but still sufficient for frost sooner or later to penetrate the initial water-segregating level and freeze enough of its water *in situ* to stop the growth of the ice columns, a new and deeper segregating layer may be established and function for a time, until it too is overtaken by frost penetration and supplanted by a yet deeper segregating layer. A profile of such a soil shows many and progressively deeper segregated ice layers separated by layers of soil. Such ice layers are usually of small vertical extent, occur at irregular or more or less regular intervals, and in general are roughly parallel to each other. The heave of a soil with this structure is, as nearly as can be measured, equal to the sum of the vertical dimensions of these segregated ice layers (Taber, 1930*a*). Here too, then, the heaving is due almost entirely to the freezing of water segregated at intervals of depth from deeper layers of soil. For a detailed report on the regular and widespread occurrence of this type of structure in nature in soils with requisite grain composition, the reader is referred to the detailed studies of Kokkonen (1926) in Finland. Taber (1929), Beskow (1935), and others induced essentially the same structure in open cylinders of clay resting at the bottom in a water supply (i.e., open system), insulated against cooling on the sides, and subjected to a steep air-soil temperature gradient.

Though early fall heavings had destroyed all experimental seedlings before it made its appearance, another well-known pattern of segregated ice—storied needle ice (fig. 17)—became common on the culm bank later in the fall. While this pattern, like the preceding stratified one, was not involved in the seedling heaving described, it merits brief comment. In its ideal form it is

FIG. 17. Profile of culm heaved by storied needle ice.

characterized by two or more strata of needle ice without intervening soil layers. That is, the several stories of needle ice are generated at the same water-segregating level but with interruptions in time, the interruptions resulting in the lines demarking the stories.

In its simplest form (two stories) the development of such a pattern, assuming requisite moisture and soil texture, may be envisaged somewhat as follows: (1) A night in which an initial Kammeis develops; (2) a succeeding day with no appreciable thawing but one not cold enough to sustain uninterruptedly the needle ice development of the preceding night; hence the initial layer of needle ice ceases to grow, but persists; (3) a second night cold enough to reactivate needle ice formation and water segregation at the same level at which these processes were interrupted during the preceding day, but not cold enough for frost to penetrate more deeply into the soil to initiate a new segregating layer. The result is a new story of needle ice in immediate contact with the base of the initial story which pushes up the first (now the upper) story with its covering frozen crust. Thus the second story is generated at and by the same level as was the initial one. Roberts (1903) describes eight such stories formed in as many nights. Among numerous other reports are those of LeConte (1850), B. Woodd Smith (1884), Bouyoucos (1923), Nimmo (1928), Krumme (1935), and Hay (1936).

Conditions in nature usually alter this ideal structure more or less. Chief among these is thawing from the surface, which obliterates in whole or in part one or more of the upper (older) needle-ice stories. Recurrent thawings and their varying intensity may so destroy or blur the original storied structure that its exact history cannot be told with certainty (fig. 17).

Heaves generated by such storied needle ice, always topped by an ice-culm crust, became common on the culm site later in the season—long after all seedlings had been destroyed by simple (single-storied) Kammeis in the earlier fall. In some locations considerable areas were heaved uniformly. In others the heaves were highly localized, manifesting themselves as flattened hummocks projecting slightly above the general surface and averaging perhaps a foot in diameter (fig. 17). Doubtless local differences in culm texture, with their attendant dynamic effects on the contained water, are mainly responsible for these differential heavings.

In a period of storied ice development the temperature on an occasional night may go low enough for frost to engulf the water-segregating level, with the result that a new and deeper one is established. When this occurs a layer of soil separates the needle-ice layer produced at the new level from the layer formed at the superseded one. In the measure that this occurs the total pattern, though still essentially storied, takes on somewhat the character of both the storied and of the stratified types noted earlier. Indeed a thin soil layer may be present between all stories (Hay, 1935; Müller, 1937), each succeeding story having been generated at a new and slightly deeper level because of deeper frost penetration at each succeeding growth period.

Fukuda (1936) reports an interesting pattern which in a sense is intermediate. Needle ice 3–3.5 cm. high developed in a single night in the open. Across the needle palisade ran five horizontal and parallel bands characterized by having soil particles incorporated in the needles. Between the bands the needles were uncontaminated. The continuous temperature record of the night revealed five steep declines with intervening periods of gentler slope, both differing in duration. It was during the abrupter declines that soil particles became engulfed at the base of the growing ice needles to give rise to the five horizontal bands, the intervening uncontaminated bands corresponding to the periods of gentler decline. Moreover, the width of the bands was correlated with the duration of the respective steep and gentle declines. Apparently frost penetration during the periods of sharper temperature drops was sufficient for occasional soil particles or aggregates to become enclosed in the base of the forming ice columns; but not rapid enough to bring water segregation to a halt and initiate a new and deeper segregating layer. In consequence the ice needles were not interrupted in their growth but merely rendered turbid by the incorporated particles, hence the turbid bands. In the periods of gentle decline, on the other hand, not even this incipient frost penetration occurred, hence the clear bands corresponding to these intervals.

No such neat parallel banding was observed on the culm site, perhaps because at the time the writer was not alert to the theoretical significance of such details. However, it was noted on certain mornings that the ice columns in some areas, though continuous, contained sufficient incorporated culm particles to render them blackish, in

contrast to the silky white appearance in areas with uncontaminated needle ice. Kokkonen (1926) determined the amount (by weight) of scattered soil particle inclusions in needle ice as developed on some Finnish soils under certain conditions.

It was pointed out above that the heaved culm surface often was fissured in a pattern parallel to the prevailing northwest-southeast winds which sweep the bank. Troll (1944), in describing frost-heaved soils in the high mountains of Africa (Kenya and Basutoland), reports somewhat similar surface ridges and furrows oriented parallel to the prevailing cold and high winds of the region, though he does not speak of any flattening of the ice columns. For this phenomenon he proposes the term "Windstreifung des Kammeises" or "windgestreifter Auffrierboden." He recognizes that the ridges and furrows were not formed by the wind moving surface material prior to Kammeis development, but came into being in the course of Kammeis formation itself (longer and shorter—or lacking—columns, respectively). This conclusion is fully shared by the writer with respect to the ridging of heaved culm surfaces.

Troll sees in the unidirectional cold and high winds the direct cause of the differential Kammeis development which results in parallel heaved ridges and furrows, micromovements of the air induced by projecting soil aggregations also being implicated. If the writer interprets Troll correctly, this would mean the assumption that sufficient temperature differences are created at the ice column-generating level to result in a pattern of longer and shorter (or lacking) ice columns such that the surface is differentially heaved in more or less parallel ridges and troughs.

To the writer the phenomenon, at least on culm, seems more likely due to prior assortment and deposition of culm particles by strong prevailing winds. These local and oriented deposits, since they differ in grain-size composition, would have differing capacities for supplying water to the bases of the growing ice columns, resulting in longer and shorter columns. Preference for this interpretation of the phenomenon on culm rests on the following considerations. (1) Grain size profoundly affects the water segregating and needle-ice potential of soils (Taber, 1929, 1930*a*; Jung, 1932; Beskow, 1935; etc.). On another type of accumulated anthracite mining waste ("rock banks"—rock, but containing enough carbon to render it black) only very slight frost heaving was observed and seedling injury never occurred. After prolonged weathering the surface of such banks contains much sandlike material but none as fine as dust; at any rate, in contrast to culm banks, no dust clouds arise even on old weathered banks swept by strong winds. (2) On culm, the surface of which was level and smooth the evening before pronounced heaving occurred in the night, the anastomosing compass-oriented ridges and furrows described earlier (figs. 2, 9, 11) developed even when at most gentle winds occurred. (3) The temperature differential (assumed by the author to be implicit in Troll's suggestion), to be effective, must exist at the level where water segregation and growth of ice columns occur, i.e., even initially beneath the frozen crust. And as growth of needle ice proceeds and pushes up the crust, the critical generating level not only becomes further removed from the surface but also progressively insulated from it by the enlarging porous needle-ice stratum. It is difficult to see how in these circumstances the temperature differences in the surface layer, which must at best be slight, could be propagated to the increasingly remote generating level—especially in so consistent a pattern as to result in the anastomosing ridges and valleys on culm and the parallel ridges and furrows observed on soil by Troll.

HISTORICAL

The limited scope and objectives of the present paper preclude more than consideration of a few of the more important landmarks prior to about 1935. By that time sufficient knowledge had accumulated to provide a general understanding of frost heaving of soil in milder temperate climates. Broad coverage of the literature is available in such reviews as that of Johnson (1952). Attention is called also to several extensive bibliographic tools (*Arctic Bibliography* and *Annotated Bibliography on Snow, Ice, and Permafrost*) which, though recently inaugurated, are retroactive.

In the emergence of a correct interpretation of the mechanics of frost heaving of plants, the independent and almost simultaneous contributions of von Mohl (1860) and of Sachs (1860) deserve greater attention than has been accorded them—at least in the American literature. This is so despite the fact that neither botanist concerned himself directly with frost heaving of plants. Encountering Kammeis—for the first time in his experience—on a frosty November morning in the Schwarzwald immediately following mild rainy

weather, von Mohl gives a lucid and accurate description of its structure and genesis which is paraphrased here: A surface layer of frozen soil pushed up by subsequently developing pure ice columns resting on unfrozen soil, the columns forming from water continuously moving slowly ("nachsickern") from below through the soil voids to feed the basally growing columns. Von Mohl does not speak of the water as segregated; but there can be no doubt he clearly understood that the marked heaving of the frozen soil surface is not due to the expansion of water freezing *in situ* in the soil but to basally meristematic ice columns developing from water drawn and segregated from the unfrozen soil below. Having correctly interpreted the essential dynamics of Kammeis development on soil, he then applies—again correctly—the same interpretation to the formation of ice layers in the abscission region of leaves of woody plants. This application was not made lightly. It was the result of rigorous logic following penetrating observations on the form and structure of the developing ice layers in relation to the anatomy and histology of the immediately adjacent plant parts. (It is to be recalled that as a plant anatomist and histologist von Mohl had no peer.)

Sachs (1860) studied intensively, largely with the microscope, ice column formation on slices of pumpkin, of root crops (carrot, turnip, etc.), and to a lesser extent on soil. His keen observations, experiments, and reasoning led him to agree with von Mohl's conclusions, to which he finds it appropriate only to add some refinement in physical-chemical terminology in describing the general dynamics of the ice formation. However, Sachs goes much further than did von Mohl in analyzing the forces involved in the phenomenon, including especially the nature and behavior of water imbibed in tissues. This water, Sachs concludes, is the immediate source of the water which feeds the basally growing ice columns on plant tissues so long, and only so long, as the tissues remain unfrozen. With steep temperature gradients between air and tissue substrates no columns formed and the tissue slices froze. Gentle gradients, on the other hand (minus 3–6°R.), resulted in good column development, the height increasing with time, the tissue slices meanwhile remaining completely unfrozen. Needle ice was successfully produced on soil, it being pointed out that development is always at right angles to the surface however the latter is oriented. Sachs further concludes that in form and mode of formation the ice columns studied by him agree with those described by Elliott (1827), Herschel (1833), LeConte (1850), Caspary (1854), and others on soil and on living and dead plant parts. It should be noted, too, that Sachs presents also a highly interesting account of what may quite properly be called the anatomy and histology of ice columns, as revealed in ingenious microscopic studies on developing columns on plant tissue slices. No comparable account is known to the writer.

An earlier publication of LeConte (1850) noted above, merits more than passing mention. Prior to the work of von Mohl and of Sachs it is the most important contribution on the subject known to the writer. LeConte reported excellent observations on Kammeis development on clay soils in the southeastern United States, and on ice ribbons forming on stems of *Pluchea*. Simple experiments having convinced him that in the origin of the latter the physiology of the plant plays no part (a conclusion with which Caspary (1854) disagreed), LeConte concluded that the two phenomena are ascribable to the same and purely physical causes. Close reasoning and simple calculations led him to reject various current theories of causation: that the needle ice is in the nature of hoar frost, i.e., that the moisture came as vapor from the atmosphere or from the soil; that the cold contracts the surface layer, thus forcing up the moisture which freezes at the surface; that the protrusion of the needle ice is caused by the mere expansion of water during freezing in the soil capillaries; that its expansion between 4° and 0° C. forces the water out of the capillaries, which then freezes at the surface.

The explanation proposed by LeConte, which cannot be presented fully here, recognized that the ice filaments form essentially at the surface from water supplied from below by capillary forces. But to make the system operative, LeConte postulates an elaborate apparatus involving conically enlarged endings of the soil capillaries at the surface. The sudden freezing of the water in these endings results in the forcible upward projection of ice threads, leaving the inverted cones (or pyramids) partially empty. This ushers in capillary activity to refill the cones with water, subsequent freezings repeating the ejections. The process is thus intermittent ("paroxysmal"), consistent, Le Conte believed, with the wavy striated structure of the extruded ice columns. This conception, in which each ice fibril arises from the flaring terminus of a soil capillary, is rejected by Sachs

(1860). However, it was reenunciated by Broun (1880) decades later, though no reference to LeConte appears.

Among LeConte's other conclusions it is significant that the maintenance of the soil below the ice columns in an unfrozen state is ascribed to (1) the continual movement of warm water from below to the scene of congelation, and (2) the large amount of latent heat released as this water freezes. He recognizes further that, when Kammeis thaws, the amount of moisture at the soil surface is vastly in excess of that present before freezing. "This is the case under circumstances which are incompatible with the idea of the deposition of dew: the water must therefore have been elevated from the depths of the earth." LeConte thus quite correctly accounts for the muddiness that accompanies thawing of soil which, immediately before Kammeis developed, was well drained.

Hesselman (1907) appears to have been the first to describe clearly the essential mechanism of frost heaving of plants—conifer seedlings on drained peat bogs subject to conspicuous Kammeis development. Familiar with the work of von Mohl and of Sachs, the Swedish forester places the heaving mechanism on a sound theoretical basis by recognizing that the concept, developed by the German botanists, of the dynamics of needle-ice development in soil and on plant tissues applied equally in the plant-heaving process mediated by Kammeis. Högbom (1914) agrees with Hesselman, as does Hamberg (1915).

In America the earliest accurate description known to the author of the mechanism of seedling heaving is that of Haasis (1923). Later Bouyoucos and McCool (1928, 1929), in observations on agricultural crops, arrived at the same conclusion as regards the mechanism of plant heaving. In neither publication is European literature referred to, and the later authors apparently were unacquainted as well with the earlier work of Haasis.

Meanwhile, starting in the second decade of the present century, there began to appear the experimental studies of Taber at the University of South Carolina. Growing crystals (K_2SO_4, $CuSO_4$, etc.) in supersaturated solutions were shown to exert pressure and to lift weights, provided other crystals not under pressure are not present or do not appear (Taber, 1916, 1917). This was true "even when the crystals were of a substance that separated from solution with a net decrease in volume." Having proved this, Taber turned his attention to frost heaving in soils. Metal weights placed on moist clay subjected to freezing during cold nights were lifted by virtually pure ice ("needle ice") forming between the surface of the clay and the bottom of the weights. On sand similarly treated no such pure ice formed on the surface nor were the weights lifted, though the water in the sand interstices was frozen, binding the weights to the sand (Taber, 1918*a*, 1918*b*). The distance through which the weights were elevated on clay approximately equaled the thickness of the layer of needle ice. The volume increase water undergoes on freezing thus played no perceptible role in the heaving of the weights, the latter attributed by Taber wholly to the basal growth of the needle ice at the expense of water moving up from below.

This water movement and needle-ice formation is possible because of the depressed freezing point of water in the minute interstices of clay, i.e., frost did not penetrate the clay when the rapid cooling of the metal weights had initiated ice formation in the film of water between the weights and the clay substrate. In sand the freezing point of water in the relatively large voids is not appreciably depressed. When, therefore, the cooling weights similarly initiated ice formation in the corresponding water film, frost penetrated the sand, progressively freezing the interstitial water, with no perceptible lifting of the weights though subject to the expansion of water on freezing.

Of Taber's subsequent extensive laboratory studies (1929, 1930*a*), employing principally open system cylinders of soil insulated on the sides and cooled only from the top by controlled temperatures, Münichsdorfer (1935), Johnson (1952), and many others have provided more or less extensive digests. It is therefore unnecessary to do more here than to recall those findings in Taber's pioneering studies which have a more immediate bearing on the subject of the present paper.

(1) The negligible role which (at least in temperate climates) the expansion of water on freezing plays in soil heaving was demonstrated further by subjecting to surface cooling soil cylinders in which nitrobenzene or benzene was substituted for water. In both cases heaving of the surface occurred as in water-moist soil, i.e., segregated frozen layers of the organic liquids formed, despite the fact that both liquids freeze with a net decrease in volume.

(2) The common assumption that soil heaves upward because this is the pathway of least re-

sistance was disproved. Simple ingenious experiments demonstrated that, except at great pressures, the direction of heaving corresponds with the dominant direction of heat loss. In test tubes filled with moist clay buried up to the open end in insulating dry sand and subjected to freezing temperatures only from above, the segregated ice needles developed vertically, i.e., in the direction of principal cooling, or at right angles to the cooling surface. Cracks developed in the unfrozen clay below as water was withdrawn to nourish the growing needle ice above—an actual shrinkage of the soil. And no tube broke.[7] If, on the other hand, the tubes were cooled from the sides, the segregated needle ice again developed parallel to the principal direction of heat loss and perpendicular to the cooling sides of the tubes. But in doing so it was not following the line of least resistance, for all the tubes were ruptured by the pressure the growing needle ice exerted on the walls.

In other experiments, heavy copper bars were inserted vertically in open system cylinders of wet clay contained in cylindrical cartons. The latter were plunged vertically in dry insulating sand and subjected to freezing temperatures. By this arrangement the cooling was applied at the upper end of the clay cylinders, including the ends of the inserted copper bars. Copper being a vastly better conductor of heat than is moist clay, the buried bars became the principal pathways for conducting heat away from the interior of the soil to the top of the cylinders; i.e., the cooling of the soil was essentially radial—perpendicular to the bars. Radially arranged needle ice 1 cm. thick formed around the copper bars, that is, the ice crystals grew in the direction of principal heat flow (cooling). And as in the test tube experiments, all cartons were ruptured by the pressure of the radially growing needle ice, which here again did not follow the pathway of least resistance. In control experiments identical except for the absence of copper bars, the needle ice developed perpendicular to the upper surface—parallel to the dominant direction of cooling. That no cartons were ruptured in these controls obviously was not due to the segregated ice crystals having followed the line of least resistance in their growth.

(3) The approximate maximum pressure developed by a heaving pure clay soil was determined. In insulated open system cylinders of clay cooled from above, and with an arrangement for registering the heaving force of the surface, heaving (crystal growth) ceased when the surface load (pressure) reached nearly 12 kgm. per sq. cm. But when the apparatus was so arranged that the water with which the bottom of the cylinder of clay was in contact was put under pressure, crystal growth occurred despite the high pressure on the clay. Taber concludes that in the former case crystal growth ceased not because ice could not form under greater pressure but because under such pressure water could no longer reach the base of the crystals.

(4) The relation to heaving of the size of soil particles (and the attendant effects on the size and other characteristics of the soil voids) also received attention. In general, heaving increased with decrease in particle size down to a point at which the soil became impervious, thus interfering with water movement. Above a grain size of about 0.07 mm. little or no segregation occurred, even under favorable conditions of temperature and water supply. Good segregation, on the other hand, took place in soils with grains 1 μ or less in size. In mixtures, e.g., sand and clay, the fine grained component had to be substantial (*ca.* 30 per cent) before segregation and heaving occurred.

Important work in Sweden, notably that of Beskow (1935), confirmed the principles established by Taber and added greatly to both theoretical and applied knowledge in this rapidly expanding field.

KAMMEIS AND PLANT COLONIZATION

The problem of plant colonization of culm sites in Pennsylvania will be dealt with elsewhere; but it may be remarked here that it probably is rare indeed that any of the vanishingly few seedlings which may survive the harsh vicissitudes of the growing season fail to succumb later to the frost heaving described. The latter must be considered another powerful factor in the extremely slow spontaneous colonization of culm areas, many of which in fact remain completely barren. Though the role of Kammeis in plant colonization cannot be pursued here, attention is called to the valuable

[7] In this experiment the system was obviously a closed one, the only water available for needle-ice formation being that contained in the moist clay within the tube. In open system procedures, on the other hand, the cylinders of soil stand in water at the lower end, providing an unlimited supply of water. In closed system experiments Taber found that needle-ice development at the expense of water from below invariably resulted in soil shrinkage, usually accompanied by the appearance of tensional cracks.

summary Troll (1944) provides on the geographical distribution of Kammeis with reference both to effects on soil morphology and on vegetation. In this connection his observations on the influence of Kammeis on vegetation of high mountains, notably in tropical regions, are especially interesting. Here, where striking Kammeis formation and thawing tend to be diurnal rather than seasonal in occurrence, even fertile areas subject to marked Kammeis action may remain completely devoid of vegetation. At the same time, on nearby talus slopes and other unfavorable and less fertile terrain not subject to Kammeis action, vegetation ascends to considerably higher altitudes. Here may be recalled also Hesselman's observations (1907) on drained peat bogs in Sweden, areas of which remain almost without vegetation because of the destructive action on seedlings of the abundant Kammeis. Mohaupt (1932) also contributes observations on the effects of Kammeis on vegetation of alpine regions.

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ANDRÉ MICHAUX'S NEW JERSEY GARDEN AND PIERRE PAUL SAUNIER, JOURNEYMAN GARDENER

WILLIAM J. ROBBINS AND MARY CHRISTINE HOWSON *

The New York Botanical Garden and Department of Botany, Columbia University

THE discovery of America opened a new world for Europeans, a world of curiosities and of riches, not the least of which were the plants; especially various magnificent trees equalling or surpassing those already known. Attention was first directed to the tropics with its precious metals and lush growth, but in time North America, more like Europe in its climate, assumed greater prominence and information on the plants of that great continent began to reach Europe and to arouse the interest of botanists, horticulturists, and even governments. Demands for seeds and plants were made on captains of vessels coming to North America, on government representatives stationed in the New World and on residents who had the necessary time, inclination, and knowledge. It is difficult for us now to appreciate the excitement aroused in the eighteenth century by the plants of North America, the eagerness with which they were sought and the high hopes and great expectations with which their introduction into Europe was awaited. It was this spirit that brought André Michaux [1] in 1785 from France to the United States.

Information and scattered plant material had reached France indirectly through England and other European countries and directly from Frenchmen and others residing in the United States or going there for longer or shorter periods, but no serious systematic effort to obtain desirable plants in quantity for France had been made until Michaux's arrival. He came under appointment of the King of France, Louis XVI; established two gardens to facilitate the accumulation of seeds and plants for shipment to France; spent nearly eleven years exploring and collecting, and sent back ninety cases of seeds and some sixty thousand plants, many of which were dispersed and others ruined by neglect.

One of the gardens established by Michaux was in New Jersey, across the Hudson River from New York City, nearly opposite what is now Fortieth Street. Michaux brought with him from the Jardin des Plantes in Paris a gardener, Pierre Paul Saunier, who managed the New Jersey Garden and ended his days there. Since Michaux's New Jersey Garden was one of the earliest such institutions in the United States we have been interested in learning what we could of its history and of that of Saunier, the gardener who managed it.

The royal patent [2] or decree which follows tells the auspices under which Michaux came and the objectives for which he was sent.

> Today, the eighteenth of July 1785, His Majesty being at Versailles, and having fixed his mind on the desire which has concerned him for many years, of introducing into his kingdom and naturalizing, by intelligent and persistent culture, under the supervision of the Director and Coordinating-General of his Buildings, all the trees and forest plants which nature has developed up to the present in foreign lands, but which are of very great interest for works of art, as well as for construction, His Majesty has felt that the success of his intentions depends necessarily on the choice made by him of a subject who joins with insight ripened by experience, the faculties and energy necessary to journey to any country, and there to study the products and assemble with care for His Majesty, reports, seeds and fruits of all trees and shrubs, also of herbaceous plants, suitable for increasing the kinds of forage which one cannot augment too greatly for livestock; to include, also, all the investigations which related to Botany, and estab-

* The authors gratefully acknowledge the assistance of Dr. Gilbert Chinard in locating original documents and in critically reading the manuscript. They express their appreciation also to Mrs. Gertrude D. Hess for her generous help with microfilms and photostats.

[1] *Michaux, André* (1746–1803). Studied botany under Bernard de Jussieu. In 1779 he botanized in England and in 1780 explored Auvergne, the Pyrenees, and the north of Spain. He went to Persia as secretary to the French Consul in 1782 and remained until 1785. While in Persia, Michaux made extensive collections of seeds and plants. Sent to the United States in 1785, he returned to France in 1796. Two works bear his name, *Histoire des chênes d'Amérique*, published in 1801, and *Flora Boreali-Americana*, which appeared in 1804. Michaux's wife died eleven months after their marriage, and he never remarried.

[2] Authors' translation.

lish connections, by means of which the Administrator of Buildings could perpetuate the investigations and advantages which they should produce; and His Majesty being informed of the profound knowledge which *sieur* André Michau [*sic*], born at Versailles, of a family devoted to Agriculture, has acquired, and who captivated by his love of the Sciences has only recently terminated very difficult and useful travel in different regions, notably in Persia where he made during nearly six years a sojourn of which the results attest all that one could hope of new studies which he is disposed to attempt wherever interesting products of Nature give cause, His Majesty has resolved to attach him specially to his service: in consequence, His Majesty has taken and retained the said *sieur* André Michau with title and status of Botanist, attached to the Nurseries cultivated under the orders of the Director and Coordinator-General of the Buildings of the King, in order, for the said *sieur* Michau, to have and to hold the said post under the orders of the Director and Coordinator-General of Buildings; to make at the expense of His Majesty expeditions which are judged useful, and in the course of which His Majesty wishes and intends that the said *sieur* Michau presents himself and lives as all Ambassadors, Ministers, Residents, Consuls, Vice-consuls, Chancellors of Consulate, and all other Agents public and private for France, under the protection and immediate safeguard of His Majesty, and that in consequence, he experiences on the part of the said Agents of every rank, every support, aid and assistance, including financial, which he requires, in sickness and in health, for the furtherance of his labors, their protection, the preservation of his collections, and the facilitating of the expeditions and the returns which he will have to make to France, and the expenses of which will be met from the funds assigned for the administration of Buildings, under the orders of the Director and Coordinating-General. His Majesty wishes and intends, that in addition to the cost of voyages and lawful expenses, which will be paid and acquitted from the funds above indicated, the said *sieur* Michau be employed and assigned under the status of fixed expenditure of the administration of Buildings, an annual salary of two thousand pounds (livres) which will be paid on receipts as all parties with the same rank; His Majesty instructs and orders *Sieur* Count de Flahault de la Billardrie d'Angiviller,[3] his Counsellor in his Councils, Knight (Chevalier) of the Royal and Military Orders of Saint Louis and of Saint Lazare, Colonel of Cavalry, Director and Coordinating-General of his buildings, fully and tranquilly to execute, that which concerns the said *sieur* Michau in the context of the present patent (brevet) which His Majesty has, for the assurance of his wish, signed with his hand, and had countersigned by me, his Counsellor, Secretary of State and of Ordinance and Finance: Signed Louis and below signed Baron de Breteuil.[4]

The major purpose of sending Michaux to North America was to obtain plants useful for building and carpentry, for forage and for medicine; plants for decorative purposes were to be secondary. He was expected to collect billets or logs two or three feet in length and to report on how the timber was used. He was also expected to send back to France animals and birds (including the wild turkey) which might be useful in France. These instructions were stated more specifically than in the royal patent, in a memorandum prepared for Michaux and signed by d'Angiviller at Versailles, August 9, 1785, more than a month before the date of the royal patent. This memorandum also clearly implies that North America was only one of the areas to which Michaux was to be sent.

On September 26, approximately two months after the royal patent had been signed, André Michaux, accompanied by his fifteen-year-old son, François-André,[5] a journeyman gardener, Pierre Paul Saunier,[6] and a domestic, Jacques Renaud, took ship for New York where he arrived Sunday, November 13, and disembarked the next day. Michaux's arrival was welcomed by M. Otto,[7]

[3] *d'Angivillier, Count Charles Claude.* Rapidly gained power at Court at the beginning of the reign of Louis XVI and was appointed Intendant of the Jardin du Roi on the death of Buffon in 1788. He fled from France to Germany in 1791 and then to Russia, where he was associated with the Court of Empress Catherine II. He returned to Germany and died in a monastery. Elected a foreign member of the American Philosophical Society in 1784.

[4] *Breteuil, Baron Louis-Auguste de* (1730–1807). French diplomat, minister under Louis XVI.

[5] *Michaux, François-André* (1770–1855). Only child of André Michaux. Accompanied his father to the United States in 1785 and returned to France in 1790 to continue his education. He visited the United States in 1801–1803 and again in 1806. He published *Voyage à l'Ouest des monts Alleghanys* in 1804; *Mémoire sur la naturalisation des arbres, arbustes et plantes de l'Amérique septentrionale* in 1806–1808; *Histoire des arbres forestiers de l'Amérique septentrionale* in 1801 and 1813. The third edition of North American Sylva appeared in 1857. He was elected a foreign member of the American Philosophical Society in 1809 and bequeathed to the Society $6,000 which now amounts to a capital fund of over $67,000 and is retained by the Society as the Michaux Fund.

[6] The name is spelled Saulnier, Sunier, Saumier, and Saunier. Paul wrote it Saunier.

[7] *Otto, Louis-Guillaume, Comte de Moslay* (1754–1817). Accompanied Chevalier de la Luzerne to the United States in 1779 and was employed by him as minister-plenipotentiary. In May, 1785, Otto succeeded

Chargé d'affaires in New York, who had been attempting to respond, with little success, to requests for plants from Count d'Angiviller.

M. Otto wrote, November 25, 1785:

> I am not able to express, Monsieur le Comte, the satisfaction that the arrival of this Botanist has given me; I have had no hope of sending anything this year and all the requests I have made of planters of my acquaintance have been received with such indifference that I have nearly given up hope of success for commissions which you have given me.[2]

Michaux's situation was not an enviable one. He arrived late in the season for collecting. Many of the woody plants had already shed their seeds and were losing their leaves, making it difficult to identify the young plants which he wished to dig up and send back to France. He had little knowledge of the country and did not speak English. He hoped to establish a garden but foreigners were not permitted to own land in the State of New Jersey in which the plot he eventually selected was located.

However, Michaux was thirty-nine years old, in the prime of life. He had the sympathetic support of the able Louis-Guillaume Otto, who had been in the United States six years and was Chargé d'affaires when Michaux arrived. The directives in the royal patent were such that Michaux could expect every assistance possible from agents of the French government and a friendly reception from influential people in the United States.

He immediately purchased maps of the United States (for twelve dollars) and attacked the language problem by buying, on December 8, an English dictionary for one dollar and by employing an interpreter-laborer. His expense journal reports, "December 15, boots for the interpreter and one pair for me, twelve dollars." The dollar dictionary was evidently inadequate, because in January, 1786, he purchased a large English dictionary for seven dollars. By the middle of March the final payments to the interpreter are recorded, and from then on Michaux was on his own, with the help of "Le Grand Dictionnaire Anglais."

de la Luzerne temporarily as Chargé d'affaires. M. Otto's first wife was Elizabeth Livingston, and after her death he married, in 1782, Fannie Crèvecœur, daughter of M. St. John de Crèvecœur, French Consul in New York. Otto remained in the United States until 1792. He negotiated the treaty of Amiens and arranged the marriage of Napoleon to Maria Louisa of Austria. Elected a foreign member of the American Philosophical Society in 1787.

Although the royal patent gave Michaux *carte blanche* on the matter of expense, he had evidently received instructions to be as economical as possible and his letters back to France contain details of expenditures, the justification for them and reports of any savings he was able to make. For example, he found that Mr. Morris of Philadelphia,[8] to whom Michaux had a letter of credit, proposed to charge eight per cent for the exchange. On January 18, 1780, Michaux wrote to Count d'Angiviller, "M. Morris profits not only from the exchange which may be five per cent in Philadelphia but gains also three per cent by his valuing the piastre (dollar) at 108 sols,[9] while the Chamber of Commerce at New York values it at 105." Michaux did not cash his letter of credit but deposited it with M. de la Forest, Vice-Consul in New York, and obtained advances which he exchanged at the rate of 103 sols per dollar. "On the 10,000 livres which I have drawn with the approval of M. Otto at the rate of 103 sols for each dollar which I get here the department gains 500 livres which would have been turned to the benefit of M. Morris if I were served by my letter of credit to him."[2]

The matter of collecting seeds and plants was attacked with vigor. Three days (November 17) after landing he was in New Jersey, collecting. November 24 he went to Elizabeth-town (Elizabeth, New Jersey) with several laborers to obtain seeds and trees, and on the twenty-eighth made a similar trip to Long Island with laborers, mattocks, and various tools. Between December 1 and 15, having purchased winter clothes for himself at a cost of $14.75, he went with laborers twice to Elizabeth-town and also to New-Ark (Newark, New Jersey), a trip which necessitated the crossing of three rivers, to Harlem (now part

[8] Probably *Morris, Robert* (1734–1806). Signer of the Declaration of Independence. Member Continental Congress of 1775, 1777 and 1778. Elected Superintendent of Finance in 1781. Organized the Bank of North America in 1781. Member of Pennsylvania legislature and a member of the convention that framed the United States Constitution. Member U. S. Senate 1788–1795. Went bankrupt owing to failure of speculations and spent 1798–1802 in debtor's prison. Elected a member of the American Philosophical Society in 1786.

[9] The units of money in the Michaux manuscripts we have consulted were valued as follows:

1 piastre—1 dollar—8 shillings—5 livres—100 sols
1 pound (N. Y.)—2½ dollars
1 livre—1 pound (French)—1 franc—20 sols
1 sol—1 sou
1 #—1 livre

of Manhattan, New York City), and to Snake-Hill in New Jersey.

In December he sent five boxes, including acorns of the red and white oak, American chestnuts, the tulip tree, locust, liquid-ambar, laurel, azalea, *Vaccinium*, and numerous other plants. A cage of eighteen partridges accompanied this shipment.

By January 18, 1786, Michaux could write Count d'Angiviller that he was shipping twelve boxes of interesting trees; numbers one to ten for the Botanical Garden of Paris, number eleven for M. LeRoy to be planted in the "Plaisiron" of His Majesty and number twelve for M. de Malesherbes.[10] Eleven of the boxes contained useful trees and one, trees and shrubs for ornament. He would have sent more but cold and snow prevented. Included in the shipment were 365 *Cupressus thyoides* (*Chamaecyparis thyoides* (L) BSP.) which Michaux considered to be a choice plant and suitable for parts of France.

Michaux wrote also to Lemonnier[11] about these two shipments, adding further details about the plants; for example, about a vaccinium which was called "Cramberrie" with fruit as large as a cherry from which a confiture was made. He even sent a bottle of fruits with a little water to keep them in their natural state. We can almost see him writing to France about his collections an hour after midnight in early December, 1785, seated in a very small unheated room when he had been told that evening "it would not be surprising if the rivers froze before morning, something which happens frequently here."

These collections were not made without difficulty. In December, 1785, Michaux wrote,

> We have done our best to make a shipment as large as possible but we have experienced considerable difficulties. The distance, the bad weather, and what is even more disagreeable, the unwillingness and laziness of the inhabitants. . . . In several places in New Jersey . . . I have frequently offered one dollar and even up to two per day and have only obtained two or three hours work. We have made our collections in that province going as far as Elizabeth-town. The vicinity of New-Ark some miles from here is very interesting because of the quantity of different kinds of trees and shrubs I recognized there. . . . I hope I can get more help from the Germans and French who are scattered through the other provinces. I am sure if I were aided by country people as one would be in France I could send every year several ships entirely filled with interesting material.[2]

The question of land for a garden also presented a problem. Michaux considered this essential because the seeds of some trees would not endure shipping, and trees which had tap roots would not survive if dug in the wild and shipped at once. But where should it be located?

Shortly after Michaux's arrival in New York, M. Otto wrote to Count d'Angiviller saying that during the winter he and Michaux could choose a convenient location in the vicinity of New York for a royal garden, and on January 18, 1786, Michaux wrote the Count that he had found a very convenient plot. Its principal advantages were proximity to extensive woods where seeds and young trees could be obtained, proximity to New York, to the Hudson River and shipping and, finally, the quality of the soil. The area comprised about twenty-nine acres of which the higher part was clayey and substantial, the middle sandy, and the lower part a cypress swamp in which magnolias and rhododendrons grew. The plot formed a rectangle, one end touching the woods along the Hudson River; the other bordering a small branch of the Hackensack River. The two sides were bounded by private holdings. The main road from New York to Hackensack traversed the plot, and if one walked in a straight line through the woods one arrived at Bull Ferry, located four miles from the Hobock (Hoboken) ferry. The price was 300 New York pounds or 3,975 livres. "This affair is not yet settled," wrote Michaux, "as the owner has not furnished all the necessary deeds. There is also some difficulty relative to the laws and customs because it is necessary to be a naturalized American to acquire land. I do not wish to act in this affair without the help of M. Otto and we wait the response of the Governor of New Jersey."[2] The property belonged to Colonel Nicholas Fish.[12]

M. Otto undertook to arrange the matter of

[10] *Malesherbes, Chrétien-Guillaume de Lamoignon de* (1721–1794). Minister of State for Louis XVI. He defended the King before the Convention and died on the scaffold.

[11] *Lemonnier, Louis Guillaume* (1717–1799). Trained as a physicist; also served as court physician. Became interested in plants as a hobby and studied them according to the Linnaean system. Attracted the attention of Louis XV and put in charge of garden of the Trianon. Sent collectors to various parts of the world, including Michaux to Persia. Though he published little in botany, he associated with the outstanding botanists of his time.

[12] *Fish, Nicholas* (1758–1833). Lieutenant-Colonel at end of Revolutionary War. Appointed adjutant-general of New York State in 1786. He was supervisor of the revenue under Washington in 1794 and an alderman of New York City from 1806 to 1817. His son, Hamilton Fish, became Governor of New York.

ownership and appealed to the Governor of New Jersey. It may have been fortunate that the wife of M. Otto was a niece of Governor Livingston [13] because on March 3, 1786, by an act of the general assembly of New Jersey, Michaux was granted permission as an alien to hold any tract or tracts of land in the state of New Jersey not exceeding two hundred acres on the one condition that this land be used for the "sole purposes of a botanical garden."

Be it Enacted by the Council and General Assembly of this State, and it is hereby Enacted by the Authority of the same, That it shall and may be lawful for the said André Michaux to purchase and to hold in Fee-simple, to him and his Heirs and Assigns for-ever, any Tract or Tracts of Land not exceeding Two Hundred Acres in the Whole, in any Part or Parts of this State, with the Tenements and Appurtenances thereunto belonging, in as full, ample and perfect a Manner as if he, the said André Michaux, was a Citizen of this State, to be appropriated to the sole Purposes of a botanical Garden, agreeably to the Prayer of the Petition, subject to like Duties as other Lands held by Citizens of this State are subjected to, any Alienage or Want of Naturalization to the Contrary thereof in anywise notwithstanding.

By March 28 an indenture between Fish and Michaux, witnessed by Mary Daubeny and Germain Bernard, was executed for lot number twenty in the County of Bergen. The lot was 29¾ acres and the price three hundred pounds current money of New York (fig. 1).

The decision to establish a garden in New Jersey was undoubtedly influenced by J. Hector St. John de Crèvecœur,[14] French Consul to New York, New Jersey, and Connecticut. Two years prior to André Michaux's arrival, Crèvecœur, on

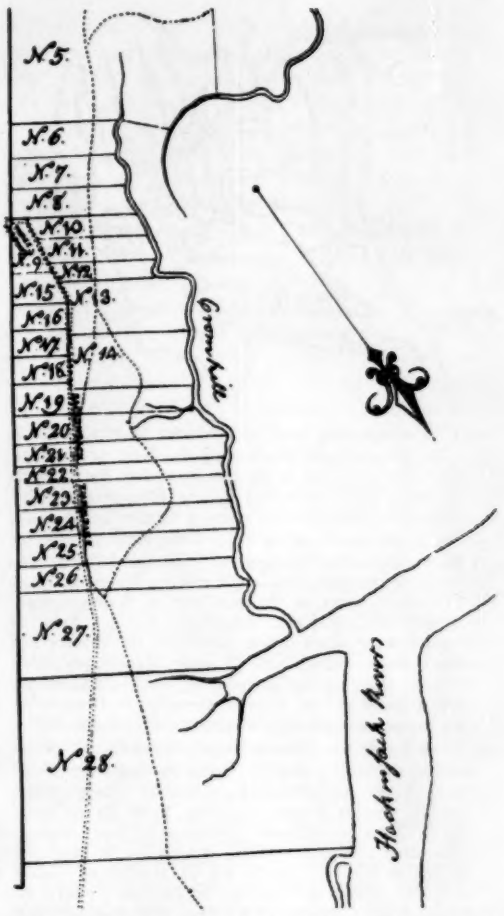

FIG. 1. Map showing lot 20 bought by Michaux for site of New Jersey Garden and lots 18 and 23 bought later by Saunier. Date of map, 1785. From Charles H. Winfield, *History of Land Titles in Hudson Co., N. J.*, 1609–1871.

behalf of the French Minister in Charge of Nurseries and Botanical Gardens in France, had written a letter to Governor Livingston in which he proposed that a botanical garden be established in New Jersey "for the cultivation of the useful and curious productions in America" [15] and promised that, if such a botanical garden were established, his Royal Majesty, King Louis XVI of France, out of his deep respect for the United States,

[13] *Livingston, William* (1723–1790). Leading lawyer of his day. Elected a deputy for the province of New Jersey to the First Continental Congress and re-elected to the Second and Third. Brigadier-general and Commander-in-Chief of the New Jersey Militia in Revolutionary War. First governor of New Jersey in 1776 and held office until his death. Member of the American Philosophical Society before 1769.

[14] *de Crèvecœur, J. Hector St. John* (1731–1813). Came to America in 1754, married an American and settled in Orange County, New York. He returned to France in 1781 after having been driven from his farm and imprisoned. He was appointed French Consul to New York, New Jersey, and Connecticut, and returned to New York in 1783 to find that his home had been destroyed and his wife had died. He returned to France in 1790. He wrote extensively and charmingly on rural life. Elected a foreign member of the American Philosophical Society in 1789. See Chinard, *Proc. Amer. Philos. Soc.* **101**: 508–522, 1957.

[15] Letter St. John de Crèvecœur to Governor Livingston, dated New Jersey, November 26, 1783. *In:* Woodward, 30.

FIG. 2. A rough map sent by Michaux to France, May, 1786, showing the location of the New Jersey Garden. On this map is the statement that the property of the King is traversed by the Hackensack Road, that it is located in a district known as Bergen's Wood and that it is six miles from New York—four by water to the Weehook (Weehawken) Ferry and two miles by land from the Ferry to Bergen's Wood. The place names on the map are: at Western edge: Aquakeneck, Newark, Elizabeth Town. East of Aquakeneck: Hackinsack. Between Hackinsack and the Hudson, going south: Riv. de Hackinsack, Chemin de Hackinsack, Branche de Hackinsack, Snake Hill (placed too far North), Bergen (on Branche de Hackinsack, somewhat southeast of Snake Hill), Newark Bay (to the southwest), Constable P. (Bayonne). Along the Hudson: Foret montagneuse, Weehook Ferry (Weehawken), Hobock Ferry (Hoboken), Paulus Hook. In New York Bay: Bucking I. (Ellis I.), Bedloes I., Oyster I. (two), Govrs. (Governor's Island). New York City is indicated by the solid color at the tip of Manhattan Island extending about to Houston or Broome Street, opposite Paulus Hook where the Hackinsack Road ends. East side of map: East River, Wallabout Bay, Ferry, Red Hook. The arrow points to the Michaux New Jersey Garden.

would send "at His Majesty's expense from his Royal Gardens every species of seed and Plants that the Director of the Botanical Gardens in New Jersey may wish to have."[15] New Jersey was ideally suited for the founding of such a botanical garden, according to Crèvecœur, because of its admirable climate and situation and the civic-mindedness of its people. The legislature of New Jersey voted to thank Crèvecœur for his gracious letter, but made no move to appropriate funds for the garden.

Michaux was most enthusiastic about the Garden. "Its greatest advantage," he said in a letter to Count d'Angiviller, "on which we congratulate ourselves every day, is that we have at our hand all the products [plants] which are found from Canada to Virginia so that one can make abundant collections and return home by dinner time."[2] He predicted that in a few years the land could be sold for twice its cost.

He immediately proceeded with the construction of a house of four rooms, two on the ground floor and two above. This was to be built at a cost of eight hundred dollars. A rough map showing the

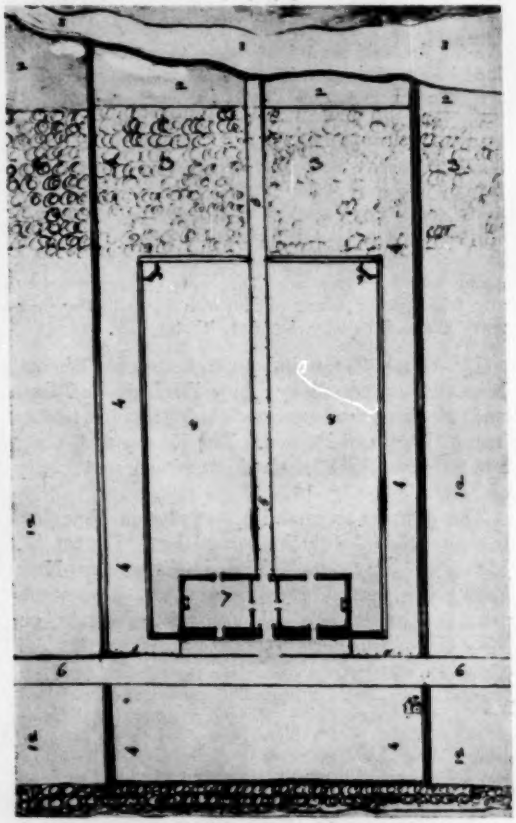

FIG. 3. Plan of the Garden sent by Michaux. The legends associated with the numbers are: (1) Branch of the Hackensack River (Cromakill Creek), (2) Prairie, (3) Cedar swamp, (4) the land between the outer double lines is the land of the King, (5) the points indicate trees planted in avenues, (6) Hackensack road, (7) floor plan of the house, (8) Garden for more precious plants and at the end, nursery for swamp plants, Carolina magnolia, etc., (9) glasshouse for tender trees, (10) gardener's house, (11) mountainous forest, (12) private lands.

FIG. 4. Michaux's sketch of the house proposed for the Garden.

location of the Garden, a plan of the Garden, and a sketch of the house, were sent to d'Angiviller May 13, 1786 (fig. 2, 3, and 4). The plan shows not only the house of four rooms, two down and two up, but separate quarters for the gardener and two small glass houses for plants too tender to stand the open winter. Michaux bought two horses, a cart, and various tools and placed Saunier in charge.

"I dare hope," Michaux wrote,

that with the good will of the gardener this establishment will also be of interest for America and will be an honor to France by sending a larger number of trees which are unknown here [U.S.A.]. In the summary of instructions which Abbé Nolin [16] has sent me for you, he has mentioned that I should offer to the Americans the useful trees which we have in France and I have set down the utility in the petition presented to the Assembly of the State of New Jersey to obtain the privilege of acquiring land without being obligated by the formalities customary for foreigners.[2]

[16] *Nolin, Abbé, Canon of St. Marcel, Paris.* Acquired a reputation in the eighteenth century for his love of plants. He collected exotic trees and shrubs and introduced them into his gardens. He published, in collaboration with Abbé Blauet, *Essay on Modern Agriculture*, Paris, 1775, which appeared anonymously. He had much of the responsibility for the care of the seeds and plants which Michaux and Saunier sent to France. His letters to Count d'Angiviller report planting plans and include comments on plants. He was much pleased to receive from Michaux, *Nelumbo*, the fruit of which he compares to a honeycomb or a bird's nest, and he proposed to plant it in the canal around the English Garden where there was "a good deal of mud and a moderate depth of water." He sent Michaux lists of seeds and plants and made knowledgeable and critical comments on the best time to ship plants, on their condition upon arrival, on how they should be packed, on the desirability of sending more seeds and fewer plants, especially those with few or no roots, and requested that the soil each species preferred should be indicated.

The tract of land bought by Michaux was located in Bergen County (now Hudson County), New Jersey, six miles from New York City—four by water to the Weehawken Ferry and two miles from there by land—and formed part of the common land of the Secaucus patent which had been surveyed and divided into lots under a supplementary act passed on August 26, 1784. The land ran southeast from the Cromakill Creek,[17] a branch of the Hackensack River, in a narrow strip approximately four hundred feet by three thousand two hundred feet, the narrow side touching the creek. It was bounded on the southwest and northeast by neighboring farms, on the northwest by the Cromakill Creek, and on the southeast by dense and hilly woodlands. Within these twenty-nine acres lay a variety of land types from cedar swamps and low marshlands bordering the creek, and sloping meadows occupying the central part, to a steep hilly area toward the southeast end.

The earliest published account of the Michaux Garden reveals an obvious misconception on the part of the general public as to the aims and purposes of the nursery. The New Jersey Journal, and Political Intelligencer of Elizabeth Town, New Jersey, on June 27, 1787, carried the following florid and quite inaccurate account:

An act has been passed by the assembly of this State for naturalizing the King of France in this State, as a preliminary to his making a purchase of thirty acres of territory on Bergen Creek, nearly opposite the City of New-York, for the purpose of a garden and, fruitery. Part of this space is at present enclosing with a stone wall, and a universal collection of exotic, as well domestic plants, trees and flowers, are already begun to be introduced to this elegant spot, which in time must rival if not exceed the most celebrated gardens of Europe. The situation is naturally wild and romantic, between two considerable rivers, in view of the main ocean, the City of New-York, the heights of Staten-Island, and a vast extent of distant mountains on the western side of the landscape.

There are many errors in this article. The King of France was never naturalized in New Jersey, and the statement that the Garden would soon "rival if not exceed the most celebrated gardens of Europe" is ludicrous in view of the small area of land, its location and topography and, moreover, completely misconstrues its purposes. There are no indications that the Garden was ever intended to be a place of beauty. It was utilitarian; a clear-

[17] Cromkill, Cromakill, or Krum Kill Creek, in some of the late maps is called Penhorn Creek.

ing house for plants to be sent to France and to be introduced into the United States.

It is little wonder that Rev. Manasseh Cutler,[18] if he had read the above glowing account was most disappointed with what he saw when he visited the Garden in July of 1787. Cutler had been told that Michaux had established a garden a few miles from Bergentown and up the Hudson River, but, when he made inquiries there, no one could, or would, give him information. He rode on through the town and at length was told that Michaux lived five miles on the way he was going, but found it nearer ten, and "the road most wretched through a lonely, hilly woods." As he came out of the woods he found a number of houses in a low sandy piece of ground surrounded by swamps; one of the houses was the Three Pigeons Tavern. There he left his horse and went on by foot about half a mile to Michaux's Garden. Michaux was in Carolina but several gardeners who "appeared to understand little of Botany" showed Cutler the garden, about which he writes thus:

> There was no order of beauty in the gardens, the soil remarkably sandy and poor, the situation wretched, and the way to it as bad as can well be conceived. Of all places in America, this would have been the very last I should have thought of for such a purpose. What could induce Mechard [André Michaux] to fix down in this awful, gloomy, lonely, miserable spot is beyond my power to conceive. I was never more disappointed and regretted the pains I had taken to see the ill taste and judgement of this Botanical Frenchman. Bill at the Three Pigeons 2 s.

Aside from the original plans sent to France by Michaux, there is, unfortunately, little information on the actual layout of the garden. Rev. Cutler says, "there were a considerable collection of exotic shrubs and plants, set in a kind of beds for transplanting. The American plants they had received were mostly sent to France."

Some idea of the layout of the Garden around 1830 as managed by Saunier's son, Michael, may be gained from the description given by H. H. Rusby,[19] who married a great-granddaughter of Saunier and visited the site of the Garden in 1884. At that time the Garden had disappeared as such, and Rusby's information came from two granddaughters of Saunier.

The major portion (about twenty acres) of the plot northwest of the Hackensack road [20] toward Cromakill Creek, much of which was a cedar swamp, was planted with chinquapin, swamp magnolias, and Kalmia. The smaller portion of about eight acres southeast of the road, now occupied by the Hoboken Cemetery, was the garden proper. A house with a driveway off the Hackensack road stood there. Either the original house was not built where Michaux had set it on his plan, or it had been replaced by a new one. A carriage house was located across the road from the house. These eight acres were partly vegetable garden and partly nursery. The high rocky ground was planted to orchard.

The southwest side of the eight acres was bordered by a hedge of arbor vitae, in great demand as a veterinary remedy under the name horse saffron. Next to the hedge was a row of *Chionanthus*. Planted on the northeastern side were persimmons, catalpas, and species of oaks not found in the nearby woods. The drive was bordered by flowering almond (*Prunus triloba*). There were large groups of sweet shrub (*Calycanthus*) and laurel (*Kalmia latifolia*). Most of the interesting shrubs growing within a radius of twenty-five miles were planted in long rows; others collected on distant excursions were represented by one or two specimens. In addition to the seeds obtained in the Garden and the nearby forests, many were collected to order by settlers living at a distance.

We are impressed by the small proportion of arable land in the twenty-nine acres Michaux bought and of which he spoke so enthusiastically. Considerable dependence must have been placed on material collected elsewhere and obtained on order from others.

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[18] *Cutler, Manasseh* (1742–1823). Ordained Congregational pastor. Chaplain in the Revolutionary War. He suddenly became interested in botany and made the first attempt at a scientific description of the plants of New England. He was instrumental in founding Marietta, Ohio, but remained only a few years in the West. Drafted for Nathan Dane the Ordinance of 1787 which excluded slavery from the Northwest Territory. Elected to Massachusetts Legislature and sent to Congress as a Federalist, serving from 1801 to 1805. Elected a member of the American Philosophical Society in 1785.

[19] *Rusby, Henry Hurd* (1855–1940). Professor of Pharmacognosy and Materia Medica, and Dean of the New York College of Pharmacy at Columbia University. One of the incorporators of The New York Botanical Garden, Honorary Curator of Economic Botany and Member of the Board of Managers of The New York Botanical Garden. Collected extensively in North and South America. Active in raising the standards of products used for food and medicine.

[20] This road is variously called Hackensack Plank Road, Hackensack Turnpike, Bergen Turnpike, and Tonnele Avenue (Hudson County) or Tonnelle Avenue (Bergen County).

Michaux was discouraged by the status of botany and horticulture he encountered in and around New York.

> One cannot count on nurserymen here as in Europe where one finds the products of distant lands gathered together in a garden. There are no informed people here, not even amateurs. There is only one nurseryman, noted for pears and apples. He indicates in his catalog some magnolias which he gets from Carolina when there is an order from Europe. I hope I will be more pleased in this respect by the South where there are wealthy people who have accumulated all the interesting productions [plants] in their gardens.[21]

He went South and visited various individuals, among them George Washington, Bartram,[22] and William Hamilton.[23]

In George Washington's diary for June 19, 1786, there is a notation:

> A Monsr. André Michaux, a Botanist sent by the Court of France to America (after having been only 6 weeks returned from India) came in a little before dinner with letters of introduction and recommendation from the Duke de Lauzen and Marqs. de la Fayette to me . . . he dined and returned afterwards to Alexandria, on his way to New York, from whence he came; and where he was about to establish a Botanical Garden.

In Michaux's Journal of Expense there is a record for September 2, 1786, of a trip to Philadelphia to visit Bartram and Hamilton.

He considered establishing a second garden in the South and thought first of one near Williamsburg, Virginia, but eventually decided on Charleston, South Carolina.

A proposal for a garden there was presented to Count d'Angiviller by M. Otto in a letter written November 25, shortly after Michaux's arrival in New York. M. Otto recommended that the consul in Charleston, M. de Chateaufort, be instructed to establish a garden, independent of the one which Michaux was instituting for the northern states, and on August 19, 1786, Michaux himself wrote the Count that he had been thinking of establishing a garden in Charleston and proposed to move Saunier to the Charleston Garden and bring another gardener to New Jersey. There is a note on this letter, probably by a French clerk, "Responded the 25th negatively to the prospect of an establishment in Carolina." We assume this date is *September* 25 and not August 25. Even so, this negative response could not have reached Michaux before he left New York with his son and the domestic for Charleston (September 23, 1786.)

With or without official approval from France, Michaux acted with his customary vigor and decisiveness. Within a few days after his arrival in Charleston he had made arrangements to purchase 111 acres of land ten miles from the city (evidently Carolina had no law prohibiting a foreigner or foreign government from owning land) and proceeded to establish a garden. For the next ten years, until his departure for France in August, 1796, he made his headquarters there; his visits to New York were infrequent and the New Jersey Garden was left largely in Saunier's hands.

Although his greater interest was at Charleston, Michaux did what he could to support the New Jersey Garden financially and to supervise its conduct. When he went to Charleston in 1786 he deposited $381 in the hands of the French Consul for the support of the New Jersey Garden. He visited it August 1, 5, 7, and 8, 1787; during this time he prepared trees for shipment to France, settled accounts with Saunier and paid him his wages. In November of the same year he received at Charleston a shipment of trees from Saunier. In August 1788, he sent M. de la Forest, French Consul in New York, a letter of credit for two thousand livres for the New Jersey Garden and in October wrote Saunier. In January, 1789, he collected seeds at Charleston, shipped them to Saunier, and wrote him a letter. In August he visited the New Jersey Garden which he found in sufficiently good condition with much seed sown and many young trees planted. To the handicaps of distance and the diversion of Michaux's interest from the northeastern United States to the south and middle west, were added the confusion and uncertainties in the government in France resulting from the Revolution (the Bastille fell July 14,

[21] Letter from André Michaux to Lemonnier, dated New York, January 26, 1786. *In*: Duprat, 244.

[22] *Bartram, William* (1739–1823). Son of John Bartram who founded in 1728 the Bartram Botanical Garden near Philadelphia. William traveled extensively in the southern United States and cared for the garden established by his father. Wrote *Travels Through North and South Carolina, Georgia, East and West Florida*, 1791. Member of the American Philosophical Society in 1769.

[23] *Hamilton, William.* Wealthy owner of famous eighteenth-century gardens known as "The Woodlands" located on the west bank of the Schuylkill River near Philadelphia. Elected a member of the American Philosophical Society in 1797.

1789; d'Angiviller fled France in July, 1791; Louis XVI was beheaded January 21, 1793).

In spite of everything shipments of seeds and plants went forward from the New Jersey Garden to France, usually to Count d'Angiviller with a covering letter from Saunier.

For example, October 24, 1787, Saunier sent thirty-four barrels of acorns and six cases of plants to the Count and a barrel of dried cuttings for M. Danbenlon (Daubenton);[24] February 18, 1788, twenty-three cases of seeds and plants and a cage of partridges, two of the cases contained seeds forwarded from Charleston;[25] April 21, 1788, six cases were sent and one box which had been forwarded from Charleston; May 15, 1788, four cases were shipped including 180 "spruces with yew leaves" (hemlock, *Tsuga canadensis*), 525 rhododendrons, 800 *Cupressus thyoides* (*Chamaecyparis thyoides*), 130 *Kalmia latifolia* and 60 spruces. Later shipments were June 9, 1788, a case of seeds of the red maple and of elm; January 2, 1790, three cases of seeds; April 26, 1790, a shipment of 90 rhododendrons, 70 *Kalmia latifolia* and 217 *Cupressus thyoides*. June 4, 1790, one case of seeds of *Acer rubrum*, American elm and *Acer glaucum* (*Acer saccharinum*); January 23, 1791, three cases of seeds. The shipment of 1791 must have arrived after d'Angiviller had left France.

By 1791 conditions had become such that the French Government decided to close the two gardens in the United States, and Michaux wrote April 15, 1791, to Count d'Angiviller that he would do everything he could to sell the New Jersey Garden at an advantageous price, but he did not expect to receive much because few improvements had been made.

> Since I have come to Carolina I have not ceased to remind Saulnier [*sic*] of his obligations, he has not paid attention, he has placed himself under the protection of the consul, he has not ceased cultivating for his own benefit potatoes, grain, and hay. A distance of four hundred miles does not permit me to visit often. He does not consider himself under my direction; only when I gave him the choice of quitting the service or following my instructions did he behave better.[2]

However, when Michaux was in New York in April, 1792, he settled accounts for the New Jersey Garden with de la Forest and visited the Garden. He was in New York again in December, 1792, but makes no reference to the Garden. He retained his interest in America after his departure because he wrote Saunier from France in 1796 and also requested support from the French government for a return to America, which was refused. He finally accompanied an expedition, led by Captain Baudin,[26] to New Holland and died in Madagascar in 1802.

The New Jersey Garden became quiescent after André Michaux's return to France. Saunier made no shipments of seeds or plants from 1792 to 1802 and had no contact with the government of France. His salary was discontinued and he paid the taxes and made the essential repairs. The garden at Charleston also lay abandoned.

The condition of the two gardens became a matter of concern to Pierre-Samuel Du Pont de Nemours[27] when he visited the United States in 1800. He wrote to the Institute of France urging that something be done to preserve them; the Institute appointed a commission and instructed it to appeal to the Minister of the Interior and to the Bureau of Agriculture. The Agricultural Bureau recommended that François-André Michaux be sent to America with instructions to sell the garden at Charleston and alienate the one in New Jersey for a period of time on condition that the grantee send annually to France a quantity of seeds and plants.

Michaux arrived in Charleston in October, 1801, quickly arranged for the sale of the garden there and wrote Saunier that he would be in New York the coming April to close the affairs of the New Jersey Garden. This news disturbed the

[24] *Daubenton, Louis Jean Marie* (1716–1799). Was trained as a physician and became assistant to Buffon in 1742. He is credited with the introduction of merino sheep and of *Cephaëlis ipecacuanha*. On the death of Buffon, he prepared a plan for the reorganization of the Jardin des Plantes which was put into effect after the Revolution. Elected foreign member of the American Philosophical Society in 1775.

[25] See appendix.

[26] *Baudin, Captain Charles* (1785–1854). Commanded the expedition sent in 1800 to New Holland which was accompanied by André Michaux and by Jacques Girard Milbert who came to the United States in 1815 where he remained for seven years, traveling widely and collecting objects of natural history for France. It seems probable that Michaux stimulated the interest of Milbert in the United States and in natural history.

[27] *Du Pont de Nemours, Pierre-Samuel* (1739–1817). French economist and statesman. Emigrated to the United States with his two sons and their families in 1799. Elected foreign member of American Philosophical Society in 1800.

Du Ponts. Eleuthère-Irénée Du Pont [28] wrote to Lapeyrouse, Mayor and Director of the Botanical Garden at Toulouse, January 12, 1802, enclosed a list of seeds, most of which had been supplied by "the manager [Saunier] of the garden of the French republic" in New Jersey, and appealed to Lapeyrouse to use his influence to preserve the gardens. Du Pont wrote also to Thouin [29] and Saunier addressed a letter to the Minister of the Interior [Chaptal].[30] Pierre-Samuel Du Pont who was in Paris at the time brought his personal influence to bear on the Minister. These requests were effective because Chaptal wrote Saunier on April 27, 1802:

I have received, citizen, the letter that you wrote me on the 28th of last January, in which you state the objections to the suppression of the establishment that you direct, of which you have been advised by Cit. Michaux, Jr. I have considered the suggestions that have been sent to me by Cit. du Pont, member of the Institut national and I have directed Cit. Michaux to discontinue his arrangements for any sale of the French Gardens in America. He will, for the present, confine his duties to examining your accounts with the assistance of Cit. du Pont and in carrying out other instructions that I have given him.

I Salute you.

Chaptal.

It is quite clear that François-André Michaux had a poor opinion of the New Jersey Garden, its management and its potential usefulness. The attitude of Michaux the younger may have been influenced in part by the somewhat unfavorable judgment of Michaux the elder. It seems probable that Saunier always considered himself under the orders of the French Government and never really felt that André or François-André Michaux had the authority to determine his fate. François-André, for example, says that his father advised Saunier in 1792 of the termination of his position, an action which Saunier never acknowledged as valid.

In any event, when they met in New York in the spring of 1802 Saunier asked for back wages for ten years and compensation for monies he had spent for taxes and repairs. Michaux, who actually believed the whole enterprise should be terminated, refused to consider that any back wages were due but agreed to pay 945 francs for taxes and repairs with the understanding that Saunier himself would meet such expenses in the future. Michaux agreed also to pay 1,000 francs per annum for regular shipments of seeds and plants, an arrangement which continued at least until 1806 when 500 of the 1,000 francs were assigned to Michaux on his third trip to the United States.

Michaux's visit resulted in a burst of activity. Victor Du Pont [31] wrote his brother, E. I. Du Pont on December 27, 1802, that Saunier was packing many things for France by Michaux's orders, and again on January 12, 1803, Victor wrote his brother, "He [Saunier] comes here with enormous boxes . . . with sketches of letters to the Minister of the Interior [Chaptal] . . . left by Michaux, by order of Michaux, etc. etc., and he expects you to pay for it all."

However, Saunier never relinquished his claim for back wages. In 1803 he appealed unsuccessfully to the Minister of the Interior (Chaptal) and January 12, 1805, wrote again to the Minister of the Interior (Jean-Baptiste Nompère, Count de Champagny [32]) in part as follows:

The report you have been given of my services to the establishment [New Jersey Garden] after 1790 is not exact. Far from cultivating vegetables for my own use the land at the establishment had always been filled with seed beds. I have dug up at various times more than forty thousand seedlings which had grown too large.

It seems to me that I have the right to my wages

[28] *Dupont, Eleuthère-Irénée* (1771–1834). Took courses in botany at the Jardin des Plantes and was described as a botanist on his passport when he came to the United States in 1799. Although diverted to powder making after his arrival in the United States, he retained his interest in plants, sent seeds and plants from America to France, and was considerably involved with the Michaux New Jersey Garden.

[29] *Thouin, André* (1747–1824). Son of the head gardener of the Jardin du Roi, became head gardener at the age of seventeen on the death of his father. During the sixty years he served in this capacity, he introduced many ornamental and useful plants to France and the French colonies, trained many students, and wrote extensively on horticultural subjects. He became Professor of Horticulture at the Jardin du Roi and a member of the Academy of Sciences.

[30] *Chaptal, Jean Antoine Claude, Comte de Chanteloup* (1756–1832). French chemist and statesman. In 1799 made a Councillor of State and became Minister of the Interior, a position he held until 1804 when he retired from office after a misunderstanding with Napoleon. Same year regained favor and was made treasurer to the conservative senate. After downfall of Napoleon, he again retired into private life.

[31] *Du Pont, Victor* (1767–1827). Elder son of P. S. Du Pont; emigrated to the United States with family in 1799 and settled at Bergen Point, New Jersey, only a few miles from the Michaux Garden.

[32] *Champagny, Jean-Baptiste, Nompère, Comte de (duc De Cadore)*. Succeeded Chaptal as Minister of the Interior and served from 1804 to 1807.

since I never received notice of their termination. I have refused most advantageous offers [one was from Aaron Burr when he was Vice-President of the United States]. I have not abandoned the establishment which I regarded as a national one but preferred to remain in a state of uncertainty rather than go with my family to a lucrative post. If I am now deprived of my past wages I will have sacrificed ten years of my life and the welfare of my children uselessly. I cannot think this possible.

I have always regarded myself as the servant of the French Government and far from my heart is the idea of doing anything of which it disapproves. It is the justice of the French Government to which I appeal. Would you, Citizen Minister, take my unfortunate situation into consideration.[2]

This moving letter did not affect the bureaucrats in Paris and Saunier, as far as we can discover, was never paid the back wages he considered his due. It is possible that the garden was eventually turned over to him to satisfy his demand for justice though we have been unable to locate any documents validating such a transfer. The garden eventually came into Saunier's possession because it was part of the property owned later by his older son, Michael (fig. 5).

Saunier continued to make shipments of plants to France as long as he lived and his son Michael carried on. One of the granddaughters of Saunier described to Dr. H. H. Rusby, in 1884, the wagons

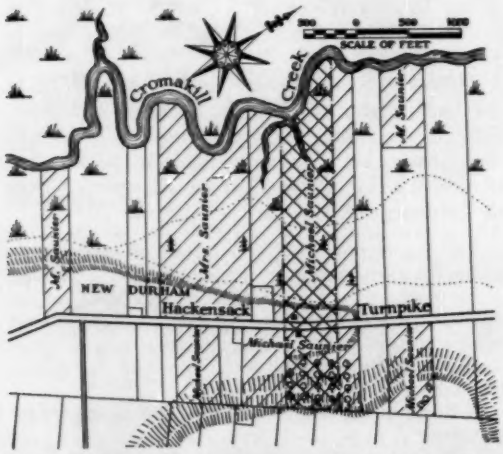

FIG. 5. Map showing property owned by Michael Saunier and Mrs. Saunier, about 1841. Adapted from L. F. Douglas Topographical Map of Jersey City, Hoboken and the adjacent country. 1841. The original location of the Michaux Garden is shown by cross-hatching.

with their great stacks of boxes looking from a distance like loads of hay. The orders steadily decreased until they ceased in the 1830's with one final shipment of three small boxes. We do not know from whom the orders came after the shipments requested by François-André had been made. For a time, E. I. Du Pont was responsible for at least some of them. In any event, sometime after 1807 the New Jersey Garden disappeared as a government institution, and in the 1830's, after nearly fifty years of service, it ceased to function as a nursery and center of supply of American plants.

The survival of the New Jersey Garden for so many years, and its service in supplying plants to France, was mainly because of Saunier's devotion, stiffened by business acumen and a concern for the personal fortunes of Pierre Paul Saunier, and to the interest and influence of the Du Pont family.

The bureaucracy of France had prepared a directive for Saunier just as it had for Michaux, though on a different level. The one for Michaux was a royal patent signed by Louis XVI himself; that for Saunier was signed by Count d'Angiviller, August 14, 1785, at Versailles and by Saunier August 18 at Paris. It begins:

> Statement of the conditions under which Pierre-Paul Saunier, apprentice gardener of the Royal Botanical Garden at Paris, born at St. Aubin in Gaillon, Bishopric of Evrena in Normandy is taken and retained in the service of the King, to go to and reside in North America and there to make under the eyes and on the instructions of *S.* Michaux, Botanist of the King, such establishment as seems possible, devoted equally to Botany and to the culture of forest trees. [2]

From various items in the directive, it appears that Saunier was expected to remain in America, probably permanently, though provision was made for the cost of transportation if he returned to France. It states that the establishment (the garden) was to be confided to Saunier's care when Michaux returned to France, that his (Saunier's) salary would be continued and that he was to make reports and an accounting every four months to Count d'Angiviller.

The directive placed considerable responsibility on Saunier, though there is some confusion on how independent he was to be. For example, he was to establish the Garden "under the eyes and on the instructions of Michaux," but if the establishment were realized its management, superin-

tendence, and conduct would be placed in Saunier's care and the necessary funds would be sent from France in cash or by letter of credit. Perhaps Michaux was not expected to remain longer in America than required to put the Garden on a firm footing.

There is, however, a second "Statement for the gardener of the nursery in America" which is not dated and is signed "Pierre Paul Saunier, age 34 years, born in St. Aubin, etc.," but by no one else. Since there is no date, it is not possible to say whether the second directive was a preliminary draft for the official document or a supplement. It is more explicit on Saunier's rights and duties and emphasizes that he was to be under Michaux's orders and supervision. It is possible that Michaux objected to the status given Saunier in the official directive, and the second one was to clarify their mutual relationship.

According to the second statement, Saunier was to receive an annual wage of eight hundred livres and to be furnished three hundred livres for his equipment for the voyage; the expense of the voyage and lodging in America until the garden was established was to be paid. He was to receive also expenses of collecting trips, but only *after certification by Michaux*. The cost of garden tools and the expenses involved in shipping seeds and plants and sending letters were to be reimbursed, but only *after approval by Michaux*. Saunier was to pay for his food, clothing, light, and all personal expenses once he was permanently located. He was to give his entire efforts to gardening *under the direction of Michaux* and was not to take orders *from anyone but Michaux*. He was enjoined not to dispose of any part of the products of the nursery or anything whatsoever *without the order of Michaux* and was not to engage in commerce of any nature. He was cautioned to be economical. To assist him in "a new kind of culture and at the same time to enlarge his knowledge of foreign trees and shrubs" Saunier was furnished with five books:

1. Miller, Philip. Dictionnaire des jardiniers. Traduit de l'Anglais par L. M. de Chazelles. sur la 8^{e} edition. 8 vol. in –4°. Paris 1785. (First ed. London, 1724.)
2. Duhamel du Monceau, Henri Louis. Traité des arbres et arbustes qui es cultivent en France en pleine terre. Paris. 1755.
3. Le Manuel de l'arboriste avec son supplément.
4. Mustel, M. Traité théorique et pratique de la végétation. Paris, 1781–1784.
5. Un catalogue complet de tous les arbres cultivés en France.

Saunier went with Michaux from Paris to the port, Lorient, where they waited a month for the ship to sail. Michaux's expense journal tells us that during this period Saunier was ill.

On their arrival in New York, Saunier was furnished board and room at city rates (about $3.50 per week) until February 14, 1786, when he and the domestic, who had been temporarily made a gardener's aid, moved to the Garden to help build the house. There, $3.50 per week was furnished for board and lodging for both men. In the meantime, Saunier was busy helping Michaux collect seeds and plants. By May 1, 1786, Saunier was established at the New Jersey Garden and on his own; no further special payments were made for his subsistence.

He found existence on his salary of about fourteen dollars per month difficult indeed, because two weeks after he was limited to his salary, Michaux wrote Count d'Angiviller requesting that Saunier be allowed to cultivate part of the Garden for himself because he could not exist on his wages, and, in August, Michaux wrote Abbé Nolin that Saunier's salary was too low. Saunier himself wrote the Abbé in August asking him to intercede with the Count to have his wages raised, and in December, 1786, Thouin wrote asking that Saunier be allowed to cultivate part of the Garden for his own profit and that his wages be increased. This barrage of appeals apparently had no effect so far as the wages were concerned because Saunier, February 18, 1788, again appealed to Count d'Angiviller for an increase in his wages. However, by 1805 Saunier claimed that his wages had been raised by d'Angiviller to twelve hundred livres in 1785. We have found no evidence that this increase had actually been granted. There is, on the communication from Thouin a note that Saunier would be permitted to cultivate part of the garden for his own profit, a provision with which Michaux was apparently unfamiliar since he later complained of Saunier's raising potatoes, grain, and hay for himself.

André Michaux never intended to remain permanently in the United States. In fact, he wrote d'Angiviller on April 15, 1791, that he was preparing to return as he had the greatest aversion to remaining in America. However, he would

delay until 1792 because before the war in America he had become involved in a shipment of merchandise to the insurgents, and he wished to collect twenty-eight thousand livres due him in Boston for his third of the transaction. He also wished to conclude some studies on the plants he had collected. François-André Michaux also never seriously considered remaining indefinitely in the United States, though he made two visits and developed close and friendly personal relations. Saunier, on the other hand, came prepared to make the United States his home.

Sometime in the late 1780's or early 1790's, Saunier married Margaret Ackerman who belonged to a Dutch-American family prominent in Bergen and Hudson County. The Sauniers had two sons, Michael and Abraham, and two daughters, Angelick and Margaret. From their tombstones we know that Michael was born in 1794 and Abraham in 1797. We do not know the birth dates of the two daughters, but Margaret was married in 1811 and Angelick in 1812, which suggests that they were born between 1790 and 1795 and approximates the date of Saunier's marriage.

Although Saunier had received permission to cultivate part of the Garden for his own profit, the area of arable land was limited to less than half the twenty-nine acres. We can understand, therefore, why Saunier proceeded to purchase additional land in the neighborhood whenever he was able. The first purchase by Paul Saunier reported in the Bergen courthouse, is from Sam and Augustus Sacket on June 3, 1790, of two lots of land "situate lying and being in the County of Bergen in the State of New Jersey known and distinguished by no. 18 and 23," for two hundred pounds current money of New York. These two lots, like the Michaux Garden which was lot No. 20, were part of the common land of the Secaucus patent surveyed and divided into lots in 1785. They ran parallel to, though not adjoining, the Garden. Lot No. 23, containing thirty-two acres, ran all the way to the Cromakill Creek, but lot No. 18 of nine and one-tenth acres extended only to the southeast side of the Hackensack Turnpike which transected both lot No. 23 and the Michaux Garden (fig. 1). The purchase of these two lots is of particular interest because some have confused them with the Michaux Garden. Winfield, in a footnote to the section dealing with lots 18 and 23, says:

> These two lots were sold by Samuel and Augustus Sacket to Paul Saunier June 3, 1780 (should be 1790). Lot No. 18 forms part of the present Macpelah Cemetery, and was part of the "Frenchman's Garden."

He further identifies the "Frenchman's Garden" with Michaux's New Jersey Garden.

Five more acquisitions of land by Paul Saunier are recorded: on August 6, 1810, from David Earle of Bergen County, for $35 of goods and lawful money, one-fifth part of a house and four acres of land bounded on the south by land of Paul Saunier; in January of 1808, from Job Smith of Secaucus and Margaret, his wife, for $255 United States money, Bergenwoods bounding on Saunier land; in October of 1813 from John Smith and his wife, Altia, for $900 a piece of upland bordered on the north by Saunier land, comprising about six acres, and a meadow bounded on the south by Saunier land comprising about four acres; on April 26, 1816, from Peter Allen and Mary, his wife, for $100 a piece of land bounded on the southeast by Paul Saunier; and on June 28, 1817, from Philip Smith and his wife for $75.00, one-fourth of an acre of land. From these deeds one is given a picture of a man who valued land and who throughout his lifetime slowly but steadily added to his estate. The total value of his purchases comes to about $2,000, United States currency.

It is interesting to speculate from where Saunier acquired the money to make these purchases. It is unlikely that by 1790 he could have saved enough from his salary of $800 per year to invest $500 in land. He may have sold produce raised on that part of the Garden which he cultivated for himself, but it is more probable that Margaret Ackerman brought a dowry when she married Saunier, and this supplied the money for the first purchase. In addition to what his wife may have brought him, Saunier, for some years after 1802, obtained funds through the Du Pont family, especially from Eleuthère-Irénée Du Pont, and probably dealt in various ways with others in the United States and France. He was sufficiently astute when it came to business matters to take advantage of any opportunity to turn an honest penny.

Eleuthère-Irénée Du Pont wrote his father (Du Pont de Nemours) April 28, 1803:

> You say nothing more, dear Papa, of the result of our complaints about the Jersey Garden. You told me in one of your first letters that the Minister [Chaptal] agreed with you about the ways of utilizing the Garden and that I would receive his instructions. You also said that Mme. Bonaparte had writ-

ten to me. I have not received those letters; and have heard nothing of the Garden except from Saulnier [*sic*], who heard me say to Victor after your letter came that we were to be authorized to deal with him and now expects me to pay him all that is due him.

In 1802 Charles Dalmas [33] sent E.-I. Du Pont a list of plants and seeds which Saunier was prepared to furnish, doubtless at a price.

Duplanty, writing E.-I. du Pont from New York in 1807, tells what Saunier would charge for white cedar suitable for making charcoal and adds the following statement:

Received by Mr. du Pont père, as given in his account with Saulnier	$474.50
Paid to Saulnier by Victor	122.25
Balance that Mr. du Pont père asks you to pay	$352.25

Saunier spent his life in Bergen managing his farm, raising his family, and caring for the Garden. Durand [34] quotes Dr. Francis [35] as saying of Saunier, "his early life was absorbed in practical horticulture, as an experimenter in vegetable physiology, and as one of the subordinates of the Jardin des Plantes. Here, he had instilled into him the principles of *ordines naturales,* by their author, de Jussieu." Since he is referred to as a "journey man gardener" and "élève du muséum" we assume that he had completed apprenticeship to his trade, horticulture, and was qualified to work at this trade for a day's wages. This early training fixed the course of his life. François-André Michaux said, "Paul was so exclusive in his attention to his avocations that hardly any other subject than trees and plants ever found entrance into his mind."

André Michaux, in December, 1785, wrote the Count, "The gardener M. Thouin has procured for us is intelligent, active and indefatigable," and on August 19, 1786, "Saunier is very active, very industrious, but in spite of his good will he is often heedless, but please, M. le Count, do not reproach him for he is sometimes overcome by discouragement and the difficulty would become worse." [2] One can understand why Saunier, far from home, attempting to live on fourteen dollars per month and working under the orders of a man so energetic as André Michaux, might at times feel discouraged.

He was not a highly educated man, though certainly above the average for his day. Pierre-Samuel Du Pont, writing to the Minister of the Interior in 1805, says that Saunier is not a botanist or a scholar and knows little of orthography, but he is a very good gardener and nurseryman and greatly loves American plants, especially those which can be of some use although he mutilates their names when he writes them. However, he never forgot that he had been "taken and retained in the service of the King" and corresponded directly with d'Angiviller, Abbé Nolin, Chaptal, and others of high station; something even a gardener in a democratic society might hesitate to do. In fact, "to the day of his death he considered his little circumscribed residence as still the property of his royal master," and reluctantly accepted the validity of the decapitation of his unfortunate king.

Saunier is said to have become a local garden oracle, giving instructions on how to bud, graft, propagate, and care for fruit trees and ornamental plants, sharing the knowledge learned at the Jardin des Plantes with all who came to him for practical gardening advice. He was a friend not only of the people in his immediate community, but also of some of the well-known scientists of his day. François-André Michaux spoke of him to Elias Durand in the highest terms, enlarging on the "refreshing enjoyment of Paul's hospitality" and Wilson,[36] the famous ornithologist, "often found shelter within his humble dwelling from the lowering sky and tempestuous storms."

[33] *Dalmas, Charles* (1777–1859). Brother-in-law of Eleuthère-Irénée du Pont.

[34] *Durand, Elias* (1794–1873). Studied medicine in Paris and received a commission in Napoleon Bonaparte's army as assistant pharmacist. On the downfall of Napoleon he emigrated to the United States where, except for brief visits to France, he spent the rest of his life. He settled first in Baltimore and then in Philadelphia where he established a drug store which ultimately became a most distinguished pharmaceutical establishment. All his life he evidenced a great interest in botany, and after his retirement at the age of fifty-eight he devoted to it his full time. He financed many botanical trips and himself made extended explorations. Elected a member of the American Philosophical Society in 1854.

[35] *Francis, John Wakefield* (1789–1861). Studied medicine under Dr. David Hosack whose partner he was until 1820. Actively promoted the New-York Historical Society and the New York Lyceum of Natural History. Among other works he wrote *Old New York, or Reminiscences of the Past Sixty Years* in 1857. Elected a member of the American Philosophical Society in 1844.

[36] *Wilson, Alexander* (1766–1813). American ornithologist. Emigrated to America from Scotland in 1794. He illustrated American ornithology in his great work, *American Ornithology,* the first volume of which was published in 1801. Elected a member of the American Philosophical Society in 1813.

Other men who visited Paul Saunier were the botanists Friedrich Pursh,[37] David Douglas,[38] and John Bradbury.[39] These men held Saunier in high esteem, regarding him as a "sort of Sir Oracle," and "his responses were heeded by all who sought practical knowledge in natural history."

Saunier is credited with introducing into cultivation a number of native American plants, among which are the chinquapin, *Castanea pumila*, and the smoking bean tree, *Catalpa bignonioides*. Shaw comments that "taking the accounts touching Saunier's novelties as related by old residents, we could find quite a variety of introductions by him. His activity in fostering and making thrifty exotic plants and shrubs was one of the characteristics of the man."

Several sources credit Saunier with the introduction of the Lombardy poplar, *Populus nigra* var. *italica*, into the United States, but this is doubtful. Ethel Armes says that the first weeping willows and the first Lombardy poplars in the Colonies grew at Woodlands, the country seat of William Hamilton, located on the west bank of the Schuylkill River near Philadelphia, which would date their probable introduction about 1745, some forty years prior to Paul Saunier's arrival in America. However, it is very possible that Saunier may have introduced the Lombardy poplar into the New York-New Jersey area. Dr. Francis recounts the history of the Lombardy poplar stating that Paul Saunier grew it first at the New Jersey Garden where it "promised a very good thing." He further states that Saunier spread the tree so that by 1800 to 1805 the trees "infested the whole island [Manhattan] if not most of the middle, northern, and many southern states."

Saunier died in 1818 at the age of sixty-seven.[40] His will reads as follows:

In the Name of God Amen. I Paul Sunier [*sic*] of the County of Bergen and State of New Jersey being very sick but of sound mind and memory and understanding considering the uncertainty of this frail and transitory Life Do pibbesh [publish] and declair this my last Will and Testament in manner and form following to wit, First my Will and Desire is that all my just debts and funeral expenc shall be paid by my Executors herein after named out of such money as I may have in my possession at the time of my death. Secondly I give and bequeath unto my son Michel Sunier all my land and tennament and all my Cattle horses and and Cows and oxes and Sheep and all my farming utensels and and my Negro Mink. Secondly I give unto my son Abraham Sunier four hundred Dollars my Cash Bonds or notes after my Decease, and four years after eighth hundred dollars and seven years after eighth Hundred Dollars to be paid By my son Michel Sunier out of my estate. I next give unto Daughter Angelick Day one hundred pounds and one Cow Fifty Pounds three years after my Decease and fifty pounds the following years after to be paid out of my estate by Michel my son. I next give unto Peggy Riker the sum of one hundred pounds and one Cow Fifty pounds three years after my Decease and fifty pounds the next years after my Decease to be paid by Michel my son. And Last I give unto my wife Peggy During her life all my possession to hold the same as I hold it in my life time and I appoint Garret New Kirk and Michel Sunier my son Executors.

Signed sealed published and Declared by the above named Paul Sunier to be his Last will and testament in the testators and in the presence of each others—

Elias Earl, Bradley Randall, Josiah Hornblower

Paul Saunier (Seal)

François-André Michaux says "Paul now lies in the Hackensac churchyard; his tomb stone records not half his excellence."

We have been unable to locate the gravestone of Pierre Paul Saunier or an authentic record of his burial place. However, he and his family were members of the English Neighborhood Reformed Church of Ridgefield, New Jersey, which was organized in 1770 and was located approximately five miles from the Michaux Garden just off the Hackensack Turnpike. In the churchyard there are gravestones for Pierre Paul's two sons, Michael and Abraham, and their wives. It is probable that Pierre Paul Saunier is buried there also. His great-great-grandson and namesake[41]

[37] *Pursh, Friedrich Traugott* (1744–1820). Botanist. Traveled twelve years in the United States, 1799–1811, and afterwards in Canada. Wrote *Flora Americae Septentrionalis* in 1814.

[38] *Douglas, David* (1800–1834). British botanist. Widely traveled. Sent to America by Horticultural Society in 1823. At Rio, 1834; in British Columbia, 1825–1827; in California, 1830–1832; on Fraser River, 1832–1833.

[39] *Bradbury, John* (1768–1817). British botanist. Collected plants in North America for Liverpool Botanic Garden, 1809–1811.

[40] According to Rusby, Saunier was seventeen years old when he came to the United States. However, the "Statement for the gardener of the Nursery in America" is signed Pierre Paul Saunier, aged thirty-four, and the Saunier family records, furnished us by his great-great-grandson, give his birth date as 1751.

[41] André Michaux had one son, François-André, who left no issue. Saunier had four children, two boys and two girls, and his descendants still reside in the United States. We have corresponded with Miss Ruth Saunier

has furnished us with a photograph taken some years ago and has marked on it the location of Pierre Paul Saunier's grave plot as fixed by family tradition. The photograph shows the English Neighborhood Reformed Church in the background. The grave plot contained a stone obelisk surrounded by six low stone posts and an iron rail. The low fence no longer exists; the obelisk is weathered and the legends, legible only in part, are as follows:

Mitchell [*sic*] Saunier died 1844 age 50 years. Eliza Vreelandt wife of Mitchell and Catherine, daughter of Mitchell and Eliza died 1847, age 17 years.

After Paul Saunier's death his elder son, Michael, took over the responsibility for the nursery business [42] and the Saunier farm. Like his father, Michael continued to purchase land adding bit by bit to his estate. A land survey map made in 1841 of Jersey City, Hoboken and the adjacent country, shows the Saunier farm to contain approximately 137 acres which included the land originally bought for the Michaux New Jersey Garden (fig. 6). The Saunier estate did not long survive the death of Michael in 1844, because a detailed land map of the North Bergen area, made in 1873, shows the Saunier property split into small land holdings, not one of which was owned by a person bearing the Saunier name.

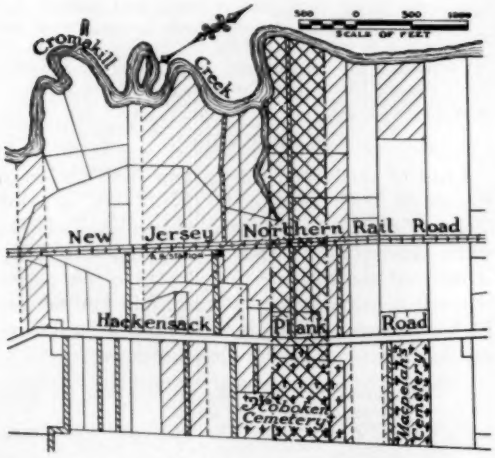

FIG. 6. Map of 1873 adapted from George H. Hopkins Combined Atlas of the State of New Jersey and the County of Hudson. The original location of the original Michaux Garden is shown by cross-hatching. Many of the small holdings are not shown.

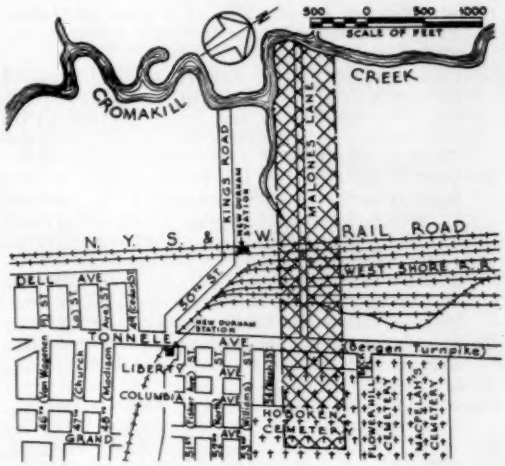

FIG. 7. A map of the area of the Michaux Garden for 1950. The original location of the Garden is shown by cross-hatching. Adapted from Map of Hudson County, Hagstrom Company, New York City.

Today the site of Michaux's New Jersey Garden is divided between the Hoboken Cemetery, warehouses, railroad tracks, and marshlands along the Cromakill Creek occupied by *Phragmites communis* Trin. (fig. 7). Nothing is left of the cedar swamp, so thick Michaux could scarcely penetrate it, nor of the magnolias and rhododendrons which grew there "in all their magnificence." Trucks and cars bound for the Lincoln or Holland tunnels, the George Washington Bridge, or elsewhere, speed along Tonnelle Avenue (Hackensack Turnpike) through the plot which was once Michaux's New Jersey Garden and the center of the life of Pierre Paul Saunier. Nothing marks the spot and no one in the neighborhood realizes that this bit of land once was of special significance to France, as well as the United States of America, and a matter of concern to some of the outstanding figures of the day.

and Pierre Paul Saunier, great-great-grandchildren of Pierre Paul Saunier.

[42] Michael Floy records in his diary for October 16, 1833, that he went to Harlem with a Mr. Saumier [*sic*] who wished to purchase one hundred large trees. This was doubtless Michael Saunier.

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Letters:

Pierre Samuel Du Pont de Nemours to Minister of the Interior of the French Republic: New York, February 8, 1802; Paris, October 20, 1803; July 13, 1805; Paris, June 5, 1806.

André Michaux to Count d'Angiviller: New York, December 1785; New York, January 18, 1786; New York, May 13, 1786; New York, August 19, 1786; Charleston, April 15, 1791.

François-André Michaux to Minister of the Interior of the French Republic: Paris, August 26, 1805.

Minister of the Interior of the French Republic to François-André Michaux: April 27, 1802.

Minister of the Interior of the French Republic to Pierre Samuel Du Pont de Nemours: April 27, 1802; October 22, 1803.

Minister of the Interior of the French Republic to Minister of Finances: Paris, July 26, 1801.

Minister of the Interior of the French Republic to Pierre Paul Saunier: October 22, 1803; Paris, May 21, 1804; Paris, February 14, 1806.

Louis-Guillaume Otto to Count d'Angiviller: New York, November 25, 1785.

Pierre Paul Saunier to Count d'Angiviller: New York, February 18, 1788; New York, April 21, 1788; New York, May 15, 1788; New York, June 9, 1788; New York, January 2, 1790; New York, April 26, 1790; New York, June 4, 1790; New York, January 23, 1791.

Pierre Paul Saunier to Monsieur Limizen: New York, October 24, 1787.

Pierre Paul Saunier to Minister of the Interior of the French Republic: Hackensack, January 28, 1802; New York, April 23, 1803; New York, January 12, 1805.

André Thouin to Count d'Angiviller: Paris, December 1, 1786.

Miscellaneous Documents:

Directive for Pierre Paul Saunier, signed by Count d'Angiviller, August 14, 1785.

Indenture between Nicholas Fish and André Michaux.

André Michaux. Journal de Dépenses, August, 1785, to March, 1787.

Memorandum on the botanical garden of the French Republic at New Jersey. April 29, 1802.

Report presented to the Minister of the Interior of the French Republic by the Bureau of Agriculture: Paris, February 16, 1801; Paris, July 1, 1801; Paris, April 18, 1802; Paris, July 26, 1805; Paris, January 31, 1806.

Royal patent which tells auspices under which Michaux came to America and the objectives for which he was sent. July 18, 1785.

Statement for the gardener of the nursery in America. Signed Pierre Paul Saunier, age 34 years.

APPENDIX

Lists of seeds and plants sent by Saunier to France in 1788, 1790, and 1791 as well as a list of material he was prepared to furnish E. I. Du Pont, November 10, 1802. The original spelling is retained and the probable identity of the plants is given in parenthesis. We are indebted to Mr. E. J. Alexander of The New York Botanical Garden for assistance in the identifications.

Envois du 20 fevrier, 1788. par Monsieur De Sionville, Commandant Le Paquebot

No. 1 pour 2-a L'addresse du Monsieur Le Comte D'Angiviller.

23 Caisses contentant Savoir.

No. 1er	Azelea nudiflora (*Rhododendron nudiflorum* (L.) Torr.)	270 pieds
	Clethra (*Clethra*)	110
2.	Clethra (*Clethra*)	425
3.	vaccinium a fleurs bleu	300
4.	vaccinium a fleurs rouge Numerote 1 (*Gaylussacia baccata* (Wang.) K. Koch.)	550
	Liquidambar perigrinum No. 2 (*Liquidambar styraciflua* L.)	300

5. Kalmia Latifolia (*Kalmia latifolia* L.) 180
6. Andromeda Caliculata (*Chamaedaphne calyculata* (L.) Moench.) 600
7. Andromeda Arborea No. 3 (*Oxydendrum arboreum* (L.) DC.) 150
   Vaccinium a fruit vert No. 4 (*Vaccinium stamineum* L.) 100
8. Azelea viscosa (*Rhododendron viscosum* (L.) Torr.) 365
9. Andromeda mariana (*Lyonia mariana* (L.) D. Don.) 460
10. Andromeda Paniculata (*Eubotrys racemosa* (L.) Nutt.) 230
11. Prinos glaber (*Ilex glabra* (L.) Gray.) 250
12. Acacia triacanthos (provenance de la papiniere) No. 5 (*Gleditsia triacanthos* L.) 940
    Mignonia Catalpa (*Catalpa bignonioides* Walt.) 1100
13. Laurus Benzoin (*Lindera Benzoin* (L.) Blume.) 100
    vaccinium arboreum 40
14. une Caisse pour le jardin du Roi a Paris
15. une Caisse de graine de Tulipier (*Liriodendron Tulipifera* L.)
16. une Caisse de graine de tulipier (*Liriodendron Tulipifera* L.)
17. une Caisse de Cypress tyoides (*Chamaecyparis thyoides* (L.) BSP.)
    Dans la meme Caisse audessus graine de Liquidambar Asplenifolium. (*Liquidambar styraciflua* L.)
18. une Caisse de graine de Nyssa aquatica (*Nyssa sylvatica* Marsh.)
19. une Caisse de graine de tulipier (*Liriodendron Tulipifera* L.)
20. une Caisse de Noix ditte Butter Nuts (*Juglans cinerea* L.)
    —— dessus un Lit de noix hycory (*Carya*)
21. Une Baril de noix ditte kisk-tomass (hickory) dans le fond un Lit de noix hycory
22. une Caisse pour le jardin du Roy a Paris
23. une Caisse contenant Savoir
    No. 1 cedre de virginie (*Juniperus virginiana* L.)
    2 graine de prinos verticulatus (*Ilex verticillata* (L.) Gray.)
    3 graine de prinos glaber. (*Ilex glabra* (L.) Gray.)

Je viens de recevoir deux Caisses numerotés 1 et 2 de Graines venant de Charlestown Envoyéer par Mr. Michaux a votre address que j'Expedie aussi par le même Paquebot et dont j'ai L honneur de vous donner avis.

Saunier

January 1790
Etat des Caisses et du Conténû de ce qu'ils renferm

No. 1 p^re C^se Renferment grenes de tulpié. (*Liriodendron Tulipifera* L.)
1 2^n Caisse Renf'—Grenes de Cesdre rouge (*Juniperus virginiana* L.)
2 Gr. de Nissatupelaut (*Nyssa sylvatica* Marsh.)
3 Magnaulia glanguér (*Magnolia virginiana* L.)
4 Sassafrer (*Sassafras albidum* (Nutt.) Nees.)
5 Cornus florida (*Cornus florida* L.)
6 Laurié benzoin (*Lindera Benzoin* (L.) Blume.)
7 Caisse 3^e renferme le pin rouge
8 Sapinette (Pines)
9 Sipré tuyá (*Thuja occidentalis* L.)
10 Agalia a fleur blanche (Azalea with white flowers)

Dans laditte Cs. les paquets sont marqué par leur nom sans numero

Catalpá (*Catalpa bignonioides* Walt.)
vinie (Vine)
virburum prunifolium (*Viburnum prunifolium* L.)
pin du Lor vimoute (Lord Weymouth pine, *Pinus Strobus* L.)
vaccinium
Ceslastrus Scondenus (*Celastrus scandens* L.)
Diyospiros lotus anqustifolius (*Diospyros virginiana* L.)
Cupressus thyoïdes (*Chamaecyparis thyoides* (L.) BSP)
Laune (Laurus ?)
Cornus sanguinea (*Cornus stolonifera* Michx.)
viburnum dantatum (*Viburnum dentatum* L.)
Micou Coulie (*Rhexia virginica* L. or *R. mariana* L.)
Arbutus enmelauchie (*Aronia arbutifolia* (L.) Ell.)
betula odorata (*Betula lenta* L.)
Cornus alternifolia (*Cornus alternifolia* L.f.)
betula alba (*Betula populifolia* Marsh.)
Epinevinette (*Berberis canadensis* Mill.)
Cornus candidisisma (*Cornus racemosa* Lam.)
Liquidanbar stirasisfluum (*Liquidambar styraciflua* L.)
Euonimus (*Euonymus*)
viorme (*Clematis*)
Serisié nouvelle spece (Cherry)
prinos glaber (*Ilex glabra* (L.) Gray.)
viburnum arboreum (*Viburnum Lentago* L.)
Celastrus bulatus (*Euonymus americanus* L.)
Agacia triaCantos (*Gleditsia triacanthos* L.)
Kalmia Latefolia (*Kalmia latifolia* L.)

Jan. 23, 1791
Liste Des graines

La caise No. 1 renferme Savoir
No. 1 Rhododendrum maccimum (*Rhodendron maximum L.*)
2 Kalmia angustifolia (*Kalmia angustifolia* L.)
3 Cèlastrus Bullatrus (*Euonymus americanus* L.)
4 Mérica Ceriféra (*Myrica pensylvanica* Loisel.)
5 Mycoucouillié (*Rhexia virginica* L. or *R. mariana* L.)
6 Béthula alba (*Betula populifolia* Marsh.)
7 Clètra (*Clethra*)
8 Cupressus thyoydes (*Chamaecyparis thyoides* (L.) BSP.)
9 Catalpa (*Catalpa bignonioides* Walt.)
10 Cornus florida (*Cornus florida* L.)
11 vaccinium a fruit vert (*Vaccinium stamineum* L.)
12 vaccinium a grappes (*Vaccinium macrocarpon* Ait.)
13 prinos glaber (*Ilex glabra* (L.) Gray.)
14 Cedre de virginie (*Juniperus virginiana* L.)

15 Bethula odorata (*Betula lenta* L.)
16 Azéléa nudyflora (*Rhododendron nudiflorum* (L.) Torr.)
17 Azéléa rubra (red Azalea)
18 Andromèda panniculata (*Eubotrys racemosa* (L.) Nutt.)
19 Andromèda plumata (*Cyrilla racemiflora* L.)
20 Kalmia latifolia (*Kalmia latifolia* L.)
21 hamamilice (*Hamamelis virginiana* L.)
22 vaccinium a fruit Noir (Vaccinium with black fruit)
23 Angélique en arbre (*Aralia spinosa* L.)
24 Céanotus americana (*Ceanothus americanus* L.)
25 Cornus Candidissima (*Cornus racemosa* Lam.)
26 Cornus Sanguinea (*Cornus stolonifera* Michx.)
27 Liquidambar Styracyfluim (*Liquidambar styraciflua* L.)
28 Nissa tupello (*Nyssa sylvatica* Marsh.)
29 Agalia blanc (White Azalea)
30 Fracsinus alba (*Fraxinus americana* L.)
31 Diospiros virginica (*Diospyros virginiana* L.)

Seize paquets de Noix Sans étiquettes Caise No. 2: renferme huit paquets de Noix aussy Sans étiquettes Le tout ensemble fait vingt quatre paquets de Noix tant especes que varietéé et un Sac de graines De Sapinette a feuille Dyfe (*Tsuga canadensis* (L.) Carr.) et graines de tulipiér (*Liriodendron Tulipifera* L.)

Caise No: 3. renferme Savoir

No. 1 gland De Chesne blanc (*Quercus alba* L.)
2 gland De Chesne a feuille de Chateignie (*Quercus Prinus* L.)
3 gland de Chesne Rouge (*Quercus borealis* var. *maxima* (Marsh.) Ashe.)
4 gland de Chesne Noir (*Quercus velutina* Lam.)
5 gland de Chesne Noir Nen *
6 gland de Chesne Rouge Nen *

Plants and seeds which Saunier was prepared to furnish E. I. du Pont, November 10, 1802.

PLANTS:

Andromeda, four kinds (*Andromeda*)
Azalea, two kinds (*Azalea*)
Kalmia, two kinds (*Kalmia*)
Gaulteria (*Gaultheria*)
Liquidember stiraciflua (*Liquidambar styraciflua* L.)
Pinus Larix (*Larix laricina* (DuRoi) K. Koch.)
Pinus Americana (*Tsuga canadensis* (L.) Carr.)
Valinium, three kinds (*Vaccinium*)
Rhododendrum (*Rhododendron*)
Spyrea, two kinds (*Spiraea*)
Cloetra altimiafolia (*Clethra alnifolia* L.)
Potentilla (*Potentilla*)
Prenos, two kinds (*Ilex*)
Cornus florida (*Cornus florida* L.)
Viburnum, three kinds (*Viburnum*)
Miryca Cerifera (*Myrica pensylvanica* Loisel.)
Dirca Palustris (*Dirca palustris* L.)
Zantorisa (*Xanthorhiza simplicissima* Marsh.)
Evominus (*Euonymus*)
Aralia spynosa (*Aralia spinosa* L.)

SEEDS:

Sassafras (*Sassafras*)
Arbutus (*Aronia arbutifolia* (L.) Ell.)
Amamelis (*Hamamelis*)
Catalpa (*Catalpa*)
Coenotus or Ceanotus (*Ceanothus*)
Brononia Radicances (*Campsis radicans* (L.) Seem.)
Acer Zacarinum (*Acer saccharinum* L.)
Cornus florida (*Cornus florida* L.)
Carpinus virginica (*Carpinus caroliniana* Walt.)
Carpinus austria (*Ostrya virginiana* (Mill.) K. Koch.)
Fraxinus alba (*Fraxinus amaricana* L.)
Acer Rubrom (*Acer rubrum* L.)
Betula nygra (*Betula nigra* L.)
Acer Pensilvania (*Acer pennsylvanicum* L.)
—— glaucum (*Acer saccharinum* L.)
Vibernum Crenatum (*Viburnum dentatum* L.)
Stafilea (*Staphylea trifolia* L.)
Seltis occidentalis (*Celtis occidentalis* L.)
Magnolia (*Magnolia*)
Nissas (*Nyssa*)
Evonimus (*Euonymus*)
Pinus trobus (*Pinus Strobus* L.)
Prinus americana (*Tsuga canadensis* (L.) Carr.)
Corrilus cornuta (*Corylus cornuta* Marsh.)
Dyaspiros or Diospiros (*Diospyros virginiana* L.)
Ulmus, two kinds (*Ulmus*)
Quercus, six kinds (*Quercus*)
Juglans, six kinds (*Juglans*)
Fagus castania (*Castanea dentata* (Marsh.) Borkh.)
Vistis vulpena (*Vitis vulpina* L.)
Tulippier (*Liriodendron Tulipifera* L.)
Padus, two kinds (*Prunus serotina* Ehrh. and *P. virginiana* L.)
Virburnum accrifolium (*Viburnum acerifolium* L.)
Cornus Alterna (*Cornus alternifolia* L.f.)
Cornus Candidiceina (*Cornus racemosa* Lam.)
Laurus Benzoin (*Lindera Benzoin* (L.) Blume.)
Viburnum Peryfolium (*Viburnum prunifolium* L.)
Cupressus Thyoides (*Chamaecyparis thyoides* (L.) BSP.)
Punis Americana (*Prunus americana* Marsh.)
Myrica cerifera (*Myrica pensylvanica* Loisel.)
Liquidamber styraciflua (*Liquidambar styraciflua* L.)
Cerberis Canadencis (*Berberis canadensis* Mill.)
Vitis labruska (*Vitis Labrusca* L.)
Orange, three kinds
Juniperus virginica (*Juniperus virginiana* L.)
Cletra (*Clethra*)
Prinos, two kinds (*Ilex*)
Andromeda, three kinds (*Andromeda*)
Kalmia (*Kalmia*)
Rhodendrom (*Rhododendron*)
Azalea, two kinds (*Azalea*)
Gleditcha triacantos (*Gleditsia triacanthos* L.)
Rhus, four kinds (*Rhus*)
Coefalentus (*Cephalanthus occidentalis* L.)

* We are uncertain of the transcription of this word and its meaning.

"THE VISION OF PIERS THE PLOWMAN" AND THE LAW OF FOUNDATIONS

HENRY ALLEN MOE

Secretary General, Guggenheim Memorial Foundation

(Dinner Address, April 25, 1958)

SIR PHILIP SIDNEY in his *An Apologie for Poetry*, first published in 1595, wrote my text:

> And, first, truly, to al them that, professing learning, inveigh against poetry, may justly be objected that they goe very neer to ungratefulnes, to seek to deface that which, in the noblest nations & languages that are known, hath been the first light-giver to ignorance and first Nurse, whose milk by little and little enabled them to feed afterwards on tougher knowledges.

I shall seek to illumine a particular case within Sir Philip Sidney's generalization; and my particular case is that William Langland's poem, *The Vision of Piers the Plowman*, written in its several forms between the year 1362 and 1377, was a "light-giver to ignorance" in defining what are and what are not valid purposes for foundations, both then and now.

By "foundations" I mean all that host of organizations set up for charitable, educational, religious, and eleemosynary purposes—of which the law says two things: the first that they *may* go on forever and the second that they need not pay taxes.

This is, indeed, the only possible definition of a foundation: that they are all those organizations which are touched neither by death nor by taxes. There is no other form of organization—except government—of which this statement can, even theoretically, be made. And all organizations of which the statement can truly be made are foundations—including the American Philosophical Society.

But this definition leaves open the question *why* the organizations called foundations are accorded the privileges of freedom from death and taxes. The usual present-day answer is that the foundations do things that the law deems to be in the public interest. But this answer is not good enough; for of course, most businesses, too, do things that the law deems to be in the public interest, and so do banks; and banks and businesses, too, may go on forever. But these are not foundations. The distinction can be explained only by recourse to history, which I now shall essay.

"There is a supernatural element in the story. Great changes take place behind a mystic veil," as Pollock and Maitland wrote in their incomparable *History of English Law*,[1] where some part of the story may be read at large.

The supernatural element in the story begins with the first recorded words of English law. These are in the laws of Aethelbert, King of the Kentish men, baptized by St. Augustine himself, at Canterbury, about A.D. 600. These first words of recorded English law—the very first words of the laws of England ever set down—are: "God's property. . . ." God is the owner of property, and so, as we shall see, are His saints, though dead.

For example, in the oldest existing English landbook, it is recorded that the newly converted Aethelbert says: "To thee Saint Andrew and to thy church at Rochester where Justus the bishop presides, do I give a portion of my land." A saint is, very often in Domesday Book, a landowner: it is there recorded that Saint Paul holds land, Saint Constantine holds land. Likewise, other saints, the martyrs of the Church, the prophets, the archangels are listed as landowners; and when someone alleges in a court that the saint is not the owner of the piece of land in question, we are treated to the spectacle—as is set forth in Domesday Book, for example—that Saint Paul is charged with an invasion of land that is said not to be his own.[2]

Of course, this kind of thinking inevitably leads to complications of theory, some of which are insoluble, and proved to be insoluble even to the medieval mind. But most of these complications need not concern us. What does concern us is this: *Why* were these parcels of land given to God, the saints, the archangels? To that question the answer is clear: they were given as the price of salvation, to make peace with Heaven. Salvation at a price is, indeed, the theme of practically all medieval wills and of many other conveyances.

[1] *The history of English law before the time of Edward I*, by Sir Frederick Pollock and Frederic William Maitland, 1: 499, Cambridge, 1911.

[2] Pollock and Maitland, *op. cit.* 1: 500.

In the legal Latin of the day, such gifts were made *pro anima mea, pro salute animae meae*—for the repose of the donors' souls. These gifts to God, the holy saints, martyrs, archangels, and others of the Lord's hierarchy, specified, often in great detail, what should be done with the income from the land and other property so conveyed: the saying of masses and of prayers for the dead, the maintenance of lamps and tapers before altars, alms for the poor, the building and endowments of churches, abbeys, monasteries and cathedrals—indeed, anything of a holy nature to keep away the devils which were supposed to surround the dying and the dead.

Even so acute and learned a lawyer as Sir Thomas Littleton (1402–1481) made provision by his will for the sale of his "great English book"—that is, his work on land tenures—and that the proceeds of the sale should be applied for the benefit of his soul, for which he made liberal provision of trentals and masses.[3]

Because these gifts, whether of land or of personal property, concerned men's souls, were given for the repose of men's souls, their enforcement was matter for the ecclesiastical courts. And the ecclesiastical courts did enforce them, according to the donors' language and intent. These gifts often were large and they were numerous throughout all the Middle Ages; and because God and the holy angels, the prophets, the martyrs, the archangels—and the churches, abbeys and cathedrals which administered these properties for God—were not subject to any temporal end, the accumulations of these properties became ever and ever larger, and threatened in time to include all property. Because all this property devoted to pious uses was under the control of the ecclesiastical courts and thus was taken out of effective governmental control through the King's courts, the question of the jurisdiction over it became the major political issue of the time and it constituted, indeed, the greatest social problem of the time.

Such, in the large, was the state of the law in fourteenth-century England on the subject of gifts to pious uses. Let us have no doubt about it: all these gifts were made as payment for the repose of some donor's soul, and on this basis they were enforced. Lord Chief Justice Wilmot in 1768 summed up the early reason of the law in this type of case: "The donation was considered as proceeding from a general principal of piety in the testator. Charity was an expiation of sin and to be rewarded in another state. . . . The Court thought that one kind of charity would embalm his (the testator's) memory as well as another, and being equally meritorious, would entitle him to the same reward" [4]—which was, as explained, salvation.

Then something happened to change the emphasis of the law, and it seemed to happen pretty abruptly in England. It had begun to happen about A.D. 1100 in Italy when Irnerius was teaching the law of ancient Rome at Bologna; and thereafter "The monarchy of theology over the intellectual world was disputed. A lay science claimed its rights, its share of men's attention. It was a science of civil life to be found in the human, heathen Digest" [5]—which was the Emperor Justinian's compilation of the law of ancient Rome. "A new force had begun to play and sooner or later every body of law in western Europe felt it."

In the sphere of this paper, Thomas Aquinas, a century after Irnerius, enlarged the range of purposes valid for gifts to pious uses. Before Aquinas, in Christendom, they had been summed up in the seven spiritual acts: to counsel, to sustain, to teach, to console, to save, to pardon, and to pray. After Aquinas, "good works," which also would avail to ensure the after-life, were held also to include seven corporal acts: to clothe, to give drink to, to feed, to free from prison, to shelter, to assist in sickness, to bury. But no emphasis whatever was placed on the social utility of such gifts in St. Thomas Aquinas's enlarged valid categories: they were still *pro salute animae meae*, for the repose of the donor's soul. As set forth "in the human, heathen Digest," it had been otherwise under the law of ancient Rome; and sooner or later every concept of what we now call the law of charities in western Europe would feel the still-living breath of the greatest law-giver of all time.

In England, the monarchy of medieval theology over the intellectual world was disputed by William Langland, who, in the latter part of the fourteenth century in England, wrote what is commonly called *The Vision of Piers the Plowman*. Some think it was written by one, others by several; but, individually or collectively, the author is called William Langland. "The Vision . . ." is probably the most completely national work in all

[3] *Dictionary of National Biography*, article "Littleton, Sir Thomas."

[4] Attorney General v. Downing, *Notes and judgments delivered in different courts by the Right Honourable Sir John Eardly Wilmot, Knt.*, London, 1802.

[5] Pollock and Maitland, *op. cit.* 1: 23–24.

English literature and it certainly is one of the richest mines for the social history of the period. The poem was in its day, and for centuries afterwards, of the greatest intellectual and practical significance. It is said that Langland's poetry was as powerful as Holy Writ; and it was. As that great French scholar, Jules Jusserand, has said of Langland, "His book had a prodigious success. . . . So great was his influence that, from out his writings, were taken watchwords of the great uprising of the peasants." [6] Wat Tyler's Rebellion occurred in 1381: the first version of Langland's "Vision . . ." had been written in 1362, less than twenty years before.

The author of "The Vision . . ." painted on the largest possible large canvas and among the many things he pictured on his huge canvas were gifts to pious uses. In Passus VII, called The Plowman's Pardon, he considered the case of merchants who had many years of remission from purgatory but could not be granted the full *a pena et a culpa* —that is, remission from both temporal and eternal punishment—because they did not keep their holy days as the Church taught and because they swore "by their soul" and "so help me God" against good conscience for the purpose of selling their wares.

But, as *The Vision of Piers the Plowman* says, Truth sent them a letter that they should take their profits—and this is the point of my exposition—

> and therewith repair hospitals,
> help sick people,
> mend bad roads,
> build up bridges that had been broken down,
> help maidens to marry or to make them nuns,
> find food for prisoners and poor people,
> put scholars to school or to some other crafts,
> help religious orders, and
> ameliorate rents or taxes [7]

—and if they did these things, Truth assured the merchants that the Lord would send Michael His Archangel to ensure that no devil should injure them or frighten them when dying; would guard them from despair and would send their souls safely to His saints in joy.

Langland's poem did not mention, as payments that would be effective for salvation, any of the most usual gifts designed, in his day, to provide for the repose of donors' souls. In wholly Catholic England, he did not specify that prayers for the dead, the saying of masses, the maintenance of lamps and tapers before altars would be effective to send the donors' souls to the saints in joy. And Langland himself, be it noted, "had received the clerical tonsure . . . and earned a precarious living by singing the *placebo, dirige* and seven psalms for the good of men's souls." [8]

Now let us jump our historical account forward two and a half centuries, from Langland to the reign of the first Elizabeth. Her father, Henry VIII, had dissolved the monasteries, had abolished the papal jurisdiction in England, had taken over the religious foundations, and had things pretty much under the control of the royal courts. What then was the position of donations formerly made to pious uses? What gifts then would, as we would put it now by our criteria, be good in law as gifts for charitable, philanthropic purposes? The answer was given in a statute of the forty-third year of the reign of Elizabeth, Chapter 4, which codified the law of charities and enumerated the purposes of gifts which were good as gifts to charitable uses. This statute is still basic in all Anglo-American jurisdictions, including the United States, for legal thinking on the subject of charitable gifts.

The statute of Elizabeth is entitled "An Act to redress the mis-employment of lands, goods, and stocks of money heretofore given to certain charitable uses." It did not make new law, but rather enacted that certain commissioners of the Crown should be empowered to see to it that lands, goods, and money given for certain charitable purposes were, in fact, then—and henceforth should be—used for the specified charitable purposes.

I am not writing a legal treatise and I shall not quote the language of the statute; but I shall say simply that the Elizabethan parliamentary draftsman included Langland's complete list of charitable objects with the exceptions that the draftsman cut down the "releve religioun" of the poem to the "repair of churches" and that one of Lang-

[6] *Piers Plowman: a contribution to the history of English mysticism*, by J. J. Jusserand, 23, London, 1894.

[7] Modern English version of the "B" text, published in *The vision of William concerning Piers the Plowman in three parallel texts by William Langland*. Edited from numerous manuscripts . . . by the Rev. Walter W. Skeat, 1: 228, Oxford, 1886. The relevant text follows:

"And amende *mesondieux* there-myde and mysese folke helpe,
And wikked wayes wi3tlich hem amende;
And do bote to brugges that to-broke were,
Marien maydenes or maken hem nonnes;
Pore peple and prisounes fynden hem here fode,
And sette scoleres to schole or to somme other craftes;
Releue religioun and renten hem bettere. . . ."

[8] Walter W. Skeat quoted in *The Encyclopaedia Britannica*, 11th edition, in article, "Langland, William."

land's enumerated purposes, to help maidens to marry or to make them nuns—"marien maydenes or maken hem nonnes"—is, in the Act of 43 Elizabeth, minus the last clause, which obviously could not, in then Protestant England, have been included.

This completeness is remarkable, but when I tell you that the legal draftsman included essentially nothing that was not in Langland's categories of two and a half centuries earlier—considering that Langland, by the legal precedent of his day, could have included a great many other categories—it seems to me very remarkable indeed. In short, the parliamentary draftsman took Langland net, and did not bother about anything Langland had not included!

Let me digress a moment to tell you what the fate of *The Vision of Piers the Plowman* had been between the time it was written in the fourteenth century and 1601, which was the date of the enactment of the statute of 43 Elizabeth, Chapter 4. Many manuscripts of it doubtless were in circulation during the intervening 250 years; but "The Vision" was first printed by Thomas Cowley, in London, in 1550; and it ran through three editions in that year.

In more modern times, forty-eight manuscripts of *The Vision of Piers the Plowman* have turned up; and they have been classified by modern scholars into "A" texts, "B" texts, and "C" texts. Thomas Cowley printed from what is now called the "B" text; and this is the point of my digression: The "B" text—which is presumably the text that it would have been easiest for the parliamentary draftsman to have available to him in the book printed by Thomas Cowley—is closer to the statute of 43 Elizabeth than either the "A" or "C" texts.[9]

I would not press my data to any but reasonable conclusions, and I shall state them very modestly. One is wise to remember what Pollock and Maitland cautioned ". . . that inquirer is fortunate who is not beguiled into positive error by the desire of making his statements less imperfect." [10]

There had been more than a thousand years of intensely complex legal development on the subject of gifts to pious uses—from the doctrine of the sacred things, the *res sacra* of the Roman Law, through the decretals of Gratian and others, the incredible learning on the subject of frankalmoign [11]—in hundreds of thousands of pages of wills, deeds, capitularies, opinions, decrees. The keenest minds of a millennium had developed the canon law on the subject of gifts to pious uses from humble beginnings into a mighty system.[12]

All this, as respects gifts to pious uses, was understood, winnowed, and stated simply in the language of the people, in *The Vision of Piers the Plowman*. Perhaps Langland was only the mouthpiece of what was in the air, but certainly he made it known, and certainly he made it effective.

I do not say, what I do not know, that the Elizabethan parliamentary draftsman had a copy of "The Vision . . ." on his table when he wrote the statute of 43 Elizabeth. But, on the other hand, I do not think it possible that the Elizabethan parliamentary draftsman never had read "The Vision . . ." However, suppose, he hadn't; suppose he only wrote down the consensus of the social thinking of his day. And if we suppose only that, we must go on to say—what we know—that the social thinking of the day was strongly influenced by *The Vision of Piers the Plowman*. And so it is clear that somebody, writing as popular poet—not a canonist and not a scholar, Langland singular or Langland plural—simplified, stated persuasively and made effective what had previously been a closed book to all but the most learned canon lawyers for more than a thousand years.

But Langland, or somebody else, did more than this: he took the purposes of gifts made *pro anima mea, pro salute animae meae* predominantly out of the class of gifts for the repose of the donor's soul and put them predominantly into the class of gifts for the general public good—gifts for the repair of bridges and roads, for the building and endowment of hospitals, for the relief of the poor, for the support of churches, for the training of scholars and craftsmen, for the endowment of learning in all its forms of scholarships, fellowships, professorships, and for the support of educational institutions generally.

Thus it is, and I think it is clear, that a poem set the salient characteristics of all the institutions of education and learning that have had an effect—unweighable, because so large—in making all of us what we are. For certainly all these institutions, with all that they do, are in the main stream of the codification which began with Langland's poem

[9] See for the relevant "A," "B," and "C" texts, Skeat, *op. cit.* 1: 228–229.

[10] Pollock and Maitland, *op. cit.* 1: 25.

[11] Frankalmoign was the tenure by which religious corporations held lands, on condition of praying for the souls of donors and their heirs, or of performing other religious services.

[12] Pollock and Maitland, *op. cit.* 1: 112.

and had its most complete legal expression with the parliamentary draftsman in the forty-third year of the reign of Tudor Elizabeth.

This is the greatest and clearest example known to me of creating understanding by simplification to essentials—a simplification which also shifted emphasis to meet social needs and in that form lived and moved through the centuries until the popular view became embodied in the legislation which yet endures. For *The Vision of Piers the Plowman* and the Act of 43 Elizabeth, Chapter 4, determine the forms, the functions, and the purposes of all those institutions for the common good which we call foundations.

This was the vision of Piers the Plowman; and, as in his vision, the motivating force of philanthropic gifts through all the ages, then and now, has been a religious one in its essence—to do good in the world, to help one's fellowmen who need help. And the function and motivating force of tax-exempt, perpetual-living philanthropic and educational foundations in society today is no different from what it has been for at least a millennium and a half.

Thanks to "The Vision . . ." we who are managers and members of foundations are numerous; we are a whole host; we are a host that stands at Armageddon and battles for the Lord.

We are a host, battling for the Lord, not only because we are numerous but also because we decide to do good works, the Lord's work, in the religious spirit of our history.

Thus, some foundations decided, long before there were laws on the subject, to prevent cruelty to children and animals. Some decided, long before there were state-supported schools, to provide education. There were societies for the prevention of tuberculosis, for the control of cancer, to provide relief from disaster, long before governments took action in these fields. Some societies, long ago and now, decided to foster religious teaching; we call these churches. Some decided to foster the propagation of the faith, whatever the particular religious faith might be; and these we call missionary societies.

The number of such voluntary organizations is legion, their purposes almost infinitely various. All of them are what the law calls foundations. Life, as we know it, would be unthinkable without them; and the good life, to which we aspire, would have much less effective bases for aspiration without them.

Government could not do what these foundations do—at least could not do what they did when they began to do it. But much that the foundations did in their beginnings has later been taken over by government to do, for the people would not stand for getting along without it—of which free public education is but one example.

In a world of awful instruments and sluggish consciences, we should thank the Lord for William Langland and for his poem. What we call a foundation provides one of the best means ever invented, possibly the best instrument ever invented, by man to control his fate.

The argument of Horace Binney in one of the Girard Will cases, before the Supreme Court of the United States in February, 1844, states the simple truth concerning the scope and power of gifts to charitable uses. "They are instruments," said Mr. Binney, ". . . in the sustenance of the poor, the instruction of the young, and the succour of the afflicted, under the vicissitudes that man is everywhere subject to—in the cultivation of learning, and the advancement of knowledge—in their tendency to consolidate and to adorn society in its progress—and . . ." because they are "moreover, under every shape and form, an acknowledgement, express and implied of our duty to God, and to our neighbor, and directly or indirectly, acts of religious worship and gratitude. . . ."

In charity, relief, and education, in the cultivation of learning, the advancement of knowledge, and the progress in culture of society, gifts to what the law calls charitable uses have been, under God, decisive.

Hence, when a scientist says—as some of them, but not the best of them, do—"In our modern world all is non-essential except science and technology; for the first virtue of any society is to put itself in position to survive," you may say to him with confidence: "Even you had a better chance for your scientific education because William Langland wrote a poem."

A text, stated in the beginning, is no good unless it has application at the end. Poetry, as Sir Philip Sidney said, has been shown to be, in my one particular case, "the first light-giver to ignorance, and first Nurse, whose milk by little and little enabled them to feed afterwards on tougher knowledges."

Our Founder, it is clear, understood better than most what William Langland had been up against; for he said, speaking through Poor Richard, "Serving God is doing good to man, but praying is thought an easier service and therefore more generally chosen."

DE WETTE IN NEW ENGLAND

SIEGFRIED B. PUKNAT

Department of Foreign Languages, University of California, Davis

AN ARTICLE on the University of Berlin in the *Christian Examiner* in November, 1836, names the illustrious professors who had been identified with that institution in the early nineteenth century, notably Fichte, Schleiermacher, Hegel, and De Wette. "Of these," the writer, Henry A. Walker, continues, "De Wette alone still survives, and toils industriously at Basle to heighten the glory that already crowns his days. The exile, though a bold innovator, is allowed on all sides to be one of the best critics and ablest writers in Germany. His works are but little obscured by the mysticism common to his countrymen, exhibiting much of the English pith, nerve, compactness, and point." [1] Here is a clue for the popularity of Wilhelm Martin Leberecht De Wette in New England in the first half of the nineteenth century—for the fact that he was one of the most extensively translated and admired German writers of the period. De Wette enjoyed the enviable reputation of being simultaneously one of the least mystical of German thinkers, a stylist who could boast of English directness and simplicity, and a theologian whose ideas harmonized with the views of the New England transcendentalists.

While the names of Eichhorn, Paulus, Neander, Strauss, and other giants among the German theologians of the late eighteenth and early nineteenth centuries have been remembered, De Wette suffered undeserved oblivion, from which several critics, and more recently studies undertaken at the University of Basel, have attempted to rescue him. Karl Barth is among those who have lamented this neglect, suggesting that in many areas De Wette anticipated important ideas later capitalized on by others.[2] His prominence in New England may be indicated by the names as well as the number of his translators. Theodore Parker, James Freeman Clarke, Samuel Osgood, and Frederick Frothingham applied their knowledge of German to De Wette, and Osgood and Clarke, at least, may have helped thereby to counteract the notion widespread in New England that the study of German was the first step toward unbelief and a fearful movement into intellectual cloudiness. When James Freeman Clarke asked Emerson to write an article on Schleiermacher, he pressed his case by citing De Wette's high regard for Schleiermacher,[3] from which one may infer Emerson's familiarity with and high regard for De Wette. And in *The Dial* itself there was severe criticism of any slighting of the "profound works of De Wette." [4] In the New England of the 1830's and 1840's De Wette was prominent among those north German thinkers whose influence played such a significant role in both American philosophy and education. Today he is least known of this group that included Lessing, Herder, Fichte, and Schleiermacher.

I

Born near Weimar on January 12, 1780, De Wette came of a long line of clergymen originating in the Netherlands in the sixteenth century. After attending Gymnasium in Weimar, where Herder was then in charge of the school system—De Wette sometimes had his lessons and oral tests at Herder's home—he entered the University of Jena in 1799, and by 1804 taught there as Privatdozent. From 1807 to 1810 he was a professor, first of philosophy and then of theology, at Heidelberg. In 1810 he became, through Schleiermacher's efforts, a professor of theology at the newly founded University of Berlin, where he worked with Schleiermacher for a period of nine years. As a result of a letter of sympathy written to the mother of Kotzebue's assassin, containing words that the Prussian government interpreted as unfriendly and offensive, De Wette was dismissed from the faculty in 1819, despite the protest of the academic senate. His refusal to accept

[1] **21**: 220.

[2] *Gesammelte Vorträge* **2**: 195, Munich, Chr. Kaiser, 1925.

[3] January 18, 1835. *Letters of Ralph Waldo Emerson*, ed. by R. L. Rusk, **1**: 425, New York, Columbia Univ. Press, 1939.

[4] By Theodore Parker in his article, German literature, *The Dial* **1**: 337, 1841.

a final quarter's salary after his dismissal suggests the moral fiber of De Wette.

The next three years he lived as a private citizen in Weimar, dedicated to his studies and to writing not only theological works but also the novel *Theodor oder des Zweiflers Weihe*, which James Freeman Clarke was to translate in the late thirties. In 1822 the rejuvenated University of Basel attracted him to that city, where he remained for twenty-seven years, until his death on June 19, 1849. His second wife, the mother of his two children, brought to her marriage with De Wette in 1809 her son by her first marriage, Karl Beck, born 1798. It was probably through his politically active stepson that De Wette took a personal interest in the young assassin, Karl Sand, at whose parental home he had once by chance visited. Karl Beck and his friend Karl Follen, who was accused of having instigated the assassination of Kotzebue, were destined to take the same road as refugees. Both first lived as teachers for several years in Switzerland, Follen for a period giving public lectures at Basel and editing with De Wette the literary journal of the university. Together Beck and Follen emigrated to America and later became professors at Harvard.

De Wette succeeded in combining scholarship with public activity in a manner especially appealing to the New Englanders. Besides his many scholarly writings in the fields of Biblical criticism, ethics, dogmatics, and education, his translation of the Bible (regarded as an outstanding achievement of accuracy), his critical edition of Luther's letters, and his creative writing (including two novels, a play, and some poems), he was active in many organizations devoted to the improvement of education and social conditions. In a poem written a half year before his death, De Wette alludes to his restless diligence in pursuit of knowledge, but laments the inadequacy of his work and what he regarded as failures in his participation in the theological battles of his day. Although he now wishes he had endured more for the ideals of freedom and justice, he is thankful that he has kept his faith free of illusion and deception. The content and spirit of these late verses reveal the persistent affinity between De Wette and the New Englanders to the end of his life, even though a return to orthodoxy was implied by his Basel colleague Hagenbach.[5] Like the New Englanders, De Wette expected a rebirth of mankind through spiritual and ethical rejuvenation by means of the Christian religion.

Herder, in many ways De Wette's model, had already attempted to fuse religion and secularism—theology and humanism—a dichotomy that became critical especially in Germany and New England. De Wette was a major figure in that movement of Biblical criticism which reached a peak in the early nineteenth century, a line of development from Spinoza in the seventeenth century, through Semler in the eighteenth, to Griesbach, Paulus, De Wette, and others in the early nineteenth century. The problem to which the historical-critical method was applied—one at the very basis of the New England controversy centered on the doctrine of miracles—was the attempt to define historical truth.

The two translations of De Wette published in George Ripley's *Specimens of Foreign Standard Literature* (14 v., Boston, 1838–1842), subsequent to the opening volumes of Jouffroy, Cousin, and Constant, may be thought of as part of Ripley's answer to Andrews Norton, who had been especially vociferous on the impious temerity of German philosophizing, on the "German insanity." It was Norton who republished in Cambridge in 1840 two articles by Professors James W. Alexander and Albert B. Dod of the Princeton Theological Seminary entitled "Transcendentalism of the Germans and of Cousin in its Influence on Opinion in this Country" (originally in the January, 1839, issue of *The Biblical Repertory and Princeton Review*). The authors of these attacks refer to the oblique entrance of German influence into New England, that is, by way of the French. After several attempts at irony, the writers inform their readers that if a transatlantic philosophy is bound to come, they want it to come "in its native robustness and freshness."[6] When they say that the French language is less fit to convey the "endless distinctions of the German," they hardly intend flattery to the Germans. Although this attack upon George Ripley does not account for the policy he had already established

[5] Hagenbach, K. R., *Rede bei der Beerdigung des Herrn Dr. und Professor W. M. L. de Wette*, Basel, 1849. The copy in the Harvard Library is inscribed "to N. L. Frothingham from L. De Wette, M.D." Biographical data are given by his children in a pamphlet attached to this publication. Further information is available in Hübschmann, A., *Nachrichten über die Familie de Wette*, Jena, 1848, and Lücke, F. (De Wette's colleague in Berlin), *W. M. L. de Wette*, Hamburg, 1850.

[6] Miller, Perry, *The Transcendentalists*, 240, Cambridge, Harvard Univ. Press, 1950.

for his series,[7] it was undoubtedly an additional stimulus to encourage him to publish De Wette. In an earlier article in *The Boston Daily Advertiser* [8] Ripley had already argued with Norton that the science of theology had received its greatest developments in Germany and that theological doctrines, such as the doctrine of miracles, could be discussed in Germany with freedom, learning, and industry.

It may be that Ripley as well as Clarke and Osgood, whose translations were to appear in the *Specimens of Foreign Standard Literature*, learned mainly through Charles Follen and Charles Beck of De Wette, although some of his works had been in use at Andover in the twenties and perhaps even a few years before 1820.[9] In his inaugural discourse at Harvard, where he became Professor of German in 1830, Follen emphasized the need on the part of the student of German literature, particularly of theological works, for direction under a guide. Follen was himself such a guide, and in his recommendations he probably mentioned the stepfather of his friend Charles Beck, whose family he had visited in Basel and with whom he had left Europe for America. In this same discourse Follen stated that whatever the degree of skepticism and the rejection of historical evidence, the Germans still embraced the spiritual essence of Christianity: ". . . it may well be said of every one who has enjoyed a German education, that his mind has been nurtured in religion." [10]

Charles Beck, who became Professor of Latin at Harvard in 1832, had excellent opportunities to become exposed to theology and its controversies after his mother married De Wette, while the latter was still a professor at Heidelberg. Beck shared with Follen an interest in the dissemination of German knowledge in New England, and probably helped make his stepfather's writings available. In 1837 he was visited by his young halfbrother, Ludwig De Wette, who in the following year described in book form his five-months stay in Cambridge and his journey in the United States and Canada.[11] The special appeal to American readers of the attitudes and style characteristic of the senior De Wette's work, in combination with the fortuitous presence of Follen and Beck in Cambridge, might well account for the astonishing reception New England afforded the writings of this remarkable man.

That New England in the first half of the nineteenth century was peculiarly receptive to the ideas of German theologians is well known. Indeed, interest in theology was one of the two or three main channels through which German thought reached New England.[12] The strongest single stimulus for New England interest in German culture was the need for theological knowledge and support, which could best be met in the writings of the theological revolution that had long been under way in Germany, that "Athenaeum of modern times," in the vocabulary of the *Christian Examiner* by 1825.[13] This is not to say that the reading of German literature, "the most profound, the most original, and the most various literature of modern Europe," in the enthusiastic view of the same periodical,[14] was exclusively the result of an interest in German theology, or that the awareness of Weimar, "the Athens of modern Europe," came only as a by-product of a concern with German theology. For better or for worse, Kotzebue was the leading playwright on the Boston stage in 1800, and Goethe and Schiller were not entirely unknown at that early date. The *Sorrows of Werther* had already been used as an appropriate volume for the bedside table of a suicide in one of the earliest American novels.[14a] In

[7] See "Editor's preface," in vol. 1.

[8] 42, November 9, 1836.

[9] *Cf. Christian Examiner* **6**: 351, July 1829.

[10] Quoted in a review, *Christian Examiner* **11**: 380, January, 1832.

[11] *Reise in den Vereinigten Staaten und Canada im Jahre 1837*, Leipzig, 1838; copy in Boston Public Library.

[12] In 1916 W. Girard (*Du Transcendentalisme considéré essentiellement dans sa définition et ses origines françaises, Univ. of California Publications in Modern Philology* **4** (3): 351–498; see especially p. 400) attributed, in a sentence, the diffusion of German idealism in America to theologians, especially Herder, Schleiermacher, and De Wette, an emphasis endorsed by G. Sherburn in his otherwise unfavorable review of this study, in *Modern Philology* **15**: 317–320, 1917. More recently, R. Wellek (Minor transcendentalists and German philosophy, *New England Quarterly* **15**: 652–680), while rejecting both the notion that interest in German thought could be ascribed to the return of the Göttingen students and the theory that German philosophy first came through Coleridge and Carlyle, has also regarded theology as supplying the motive for the study of German thought. A comprehensive account has recently been given by Pochmann, H. A., *German culture in America*, Madison, Univ. of Wisconsin Press, 1957; see especially the section on the unitarians' interest in German rational theology, 114–151. My study was completed before I had an opportunity to see this major work in the field.

[13] **2**: 262, 1825.

[14] **11**: 374, January, 1832.

[14a] See Hart, J. D., *The popular book*, 62, New York, Oxford Univ. Press, 1950; also Pochmann, *loc. cit.*, 359.

his article on Herder in the *Christian Examiner* of May, 1835, George Ripley bemoaned the fact that German theological works, or even mere information about them, were so much less accessible to the English-speaking public than were the treasures of German literature. Nevertheless, the stimulus to read German literary works came from a prime interest in German idealism among the New Englanders. This interest was either directly or indirectly tied up with native intellectual currents, the origin of which was essentially theological. Many of the more liberal theologians in New England believed that transcendentalism would save religion and that the masters of the "transcendental method" were German. This "method" was committed to the spirit of inquiry, and had proved its worth by the amazing erudition evinced in every phase of philosophy and theology.

The New Englanders were intensely conscious of having entered a state of reflection and of "inquiry concerning themselves and their destination, the nature of their being, the evidence of their knowledge, and the grounds of their faith." For many of them "the German philosophy [was] the strongest expression of that tendency." [15] In the theological controversies of the time—orthodox versus liberal, Calvinist versus Unitarian, rationalist versus supernaturalist—German theology was inevitably both attacked and defended. That "German theology" as such did not exist occurred to few of the debaters. Probably in no other European country at that time was there so much independence of inquiry and such a wide variety of speculation. The varied studies in the "science of divinity" were being pursued with a depth of research unparalleled elsewhere. Time and again it was pointed out that between orthodoxy and rationalism there was to be found in Germany almost every variety of opinion, more or less liberal, with prominent spokesmen for each. Although a better acquaintance with German theological writings was producing a fairer estimate by the early 1830's, that is, more of a balance between exaggeration and deprecation, the controversy over German theology, which began shortly before 1820, reached its peak around 1840, at the very time three important De Wette translations were about to appear, and abated in the late 1850's.

The most prominent among the early opponents of "German theology" was Professor Moses Stuart of Andover. In an 1846 postscript to his *Letters to Dr. Channing*, published originally in 1819, he sees his prophecies as having been valid. In America it will not be possible, he thinks, to go beyond Theodore Parker's position. "It needs a *German* mind and education to do this." [16] Others joined Stuart, soon after his *Letters* were published, in giving warning against indiscriminate following of German scholars. One writer, for example, suggests in his criticism the extent of theological influence by 1825:

> Every tyro in Biblical criticism has learnt to point with oracular solemnity to Germany, and to put on a countenance of portentous significancy, as he gravely proceeds to confound all the liberal inquiry in the world with the liberal inquiry of that country. . . . A spirit of extravagance has infected the literature and politics, as well as the religion of the learned in Germany.[17]

Another article ten years later contains a caveat in the report that the extreme liberals were occupying the most important pulpits as well as the most important professorships in theological schools in Germany. The writer, George R. Noyes, added that no books were more common in the libraries of young New England theologians than those emanating from Germany and that the study of the German language and literature were on the increase "and must continue to increase." [18]

A critic's attitude toward theology often determined his pronouncements on German literature. While a reviewer of a translation of *Undine* could give his verdict in favor of German literature, having just spoken of the "more profound productions of Germany, the labors of the theologians and philosophers," [19] another critic, who denounced transcendentalism as coming from Germany and as "one of the first fruits of a diseased admiration of everything from that source," lamented the fact that there were more English translations of *Faust* than of the *Iliad*, and that a version of one of Schiller's plays had a better chance of finding purchasers and readers than did a native drama. "In the literary history of the last half century, there is nothing more striking to be recorded, than the various exhibitions of this German mania. . . . Poetry, theology, philosophy, all have been in-

[15] Review of Coleridge's *Biographia literaria* and other works of Coleridge, *Christian Examiner* **14**: 120, March, 1833.

[16] *Miscellanies*, 196, Andover (Mass.), 1846.

[17] *Christian Examiner* **2**: 408, 1825.

[18] *Ibid.* **19**: 41, September, 1835.

[19] *Ibid.* **27**: 398, January, 1840.

fected." [20] Anyone who touched a German book in any field could be suspected of being on the broad road to infidelity. But the focus of attack was on theology and philosophy, and in his battle in 1839 against the modern school of German infidelity, it is Spinoza, Schleiermacher, and De Wette whom Andrews Norton singled out as special targets. Spinoza's pantheism was derided as the "public secret of Germany." [21] Orville Dewey, in *Two Discourses on Religion* (1841), outdid the rest, however, in interpreting German theology as a kind of necessary evil: "The very state of the German mind . . . is an argument with me, for the miraculous element in the Christian system." [22]

Despite the anathemas pronounced against a whole generation of German theologians, there were those who admired, and benefited by, German research, even if they could not accept German speculation *in toto*. A work such as David Friedrich Strauss' *Life of Jesus*, which Moses Stuart regarded as positive proof for his theory and prophecy, was reviewed with considerable moderation, though not without skepticism. As Theodore Parker pointed out, the work of Schleiermacher and De Wette was often as bold and remorseless and sometimes as destructive as that of Strauss. At the same time, it was rightly believed that Strauss was indebted to De Wette, as well as others, for modifications of his views.[23] Some New Englanders, such as George Bancroft as early as 1824, defended German theology as a center and main support of Protestantism.[24] Convers Francis similarly tried to create order in the chaotic reactions to German theology, asking what would be meant by such an expression as "American theology." [25] In his 1842 review of several theological works, G. W. Burnap referred to the clamor raised on the subject of German theology, which had the orthodox Hengstenberg at one extreme and Strauss at the other, and concluded that prejudice should be replaced by a study of the more moderate representatives, especially Schleiermacher and De Wette.[26] By 1857, J. H. Allen, in his review of "Recent German Theology," [27] could express his sadness that a host of obscure names and petty controversies were now occupying the ground where Lessing, Herder, Fichte, Schleiermacher, and De Wette had "waged their high controversy with error or unbelief."

To the problem of error or unbelief De Wette applied the historical-critical method. The historian attempts to create an organic whole out of the individual facts or reports that he accepts as valid.[28] This step, the imposition of continuity, wholeness, or meaning, is the poetry of history. This poetry of history, which De Wette finds more poetic than poetry itself, is an essential part of his concept of myth. Rather than separate historical fact from tradition, he regards the whole as the sacred poetry of history. He takes exception, therefore, to the attempts of those who recognize nothing supernatural in history by trying to explain everything on a natural basis. But he is not in the camps of the traditionalists, the supernaturalists, or the orthodox. His interest in myth, in mystery, in the very concept of the dignity of man and the dogma of the individual human being as part of Mind and the creative spirit, kept him from joining forces with the rationalists or the naturalists. His concept of myth helped him solve the apparent contradiction between fact and fiction. He belongs to the stream of criticism that sees the "symbol" as the very basis of poetry and in poetry the incarnation of spirit. The higher truth of the Bible—the religious idea—he removes from the realm of empirical thought to the realm of poetry. The area of religion exists for him as an essential part of human experience, and the shell of language, necessary as it is, is not identical with it. This part of De Wette's criticism, especially his *Beitrag zur Charakteristik des Hebraismus* (1807), was the source of much misunderstanding and opposition, but it attracted the attention of the liberals, including the New Englanders.

His radical approach made De Wette a target for many attacks. His extensive investigations, beginning in the Jena period, on the origin of the Gospels, their relationship to one another, his work on the Psalms, and his comprehensive introduction to the Old and the New Testament (1817–1848), a standard work which underwent many

[20] Locke and the transcendentalists, by "F. B.," *Christian Examiner* **33**: 175, November, 1837.

[21] *Christian Examiner* **28**: 380, July, 1840.

[22] Quoted in *Christian Examiner* **21**: 385, January, 1842.

[23] *Cf. Christian Examiner* **28**: 306–313, July, 1840.

[24] *Cf. Literary and historical miscellanies*, 165, New York, Harper and Brothers, 1855.

[25] *Christian Examiner* **13**: 365, January, 1833.

[26] *Ibid.* **32**: 321, July, 1842.

[27] *Ibid.* **63**: 431 ff., November, 1857.

[28] For some of the following I am indebted to K. R. Hagenbach's study, *W. M. L. De Wette*, Leipzig, Weidmann'sche Buchhandlung, 1850.

editions, gave him a fame not without a strong admixture of antagonism. Perhaps his opponents in Germany and in New England had some grounds for their fears. One of the direct results of De Wette's scholarly activities was the significant impression gained, for example, by Jakob Burckhardt. Son of a clergyman, Burckhardt originally planned to follow his father's profession, but gave this up as a result of De Wette's undermining of his faith in orthodoxy. He wrote to a friend in 1838: "De Wette's system grows before my eyes to colossal dimensions; one *must* follow him, nothing else is possible; but, alas, every day there disappears under his hands a fragment of the traditional teaching of the Church." [29] He goes on to mention De Wette's use of myth, but arrives at a conclusion quite different from any De Wette might have expected from his search for truth.

With Schleiermacher, translator of Plato and author of the famous *Reden über die Religion* (1799), he wanted to reconcile rationalism and supernaturalism in an approach that included both. For them, Christianity was neither a doctrine of reason nor mere recorded history but a living phenomenon. Their view was still christological, despite the lesson Burckhardt believed to have learned on this very issue. To be sure, ambiguities remained—or at least resulted in the opposition of both sides, as in the case of the New England transcendentalists.

Although drawn to Schleiermacher, and maintaining for many years a cordial relationship with him, De Wette went his own way. Each dedicated a work to the other, and later Schleiermacher visited De Wette at Basel. While both regarded religion as a matter of feeling, De Wette, certainly in his Berlin period, tended more toward a Kantian outlook and Schleiermacher to a Schelling-Spinozist view. Schleiermacher was much closer to the romantic movement, to Schelling, Tieck, and the Schlegels, but both sought organic knowledge, a unity in the diversity of perception. Their conception of theology is essentially philosophic. De Wette owes to his friend, the theologian Fries, an outlook that attempts to combine Kant's ethics with Jacobi's doctrine of feeling in a system that Fries called philosophic anthropology: the theory that philosophic knowledge is dependent on the self-knowledge of man. The basis of his system is threefold: knowledge, belief, and intuition—knowledge of things, belief in the eternal nature of things, intuition of the eternal or infinite in the finite. De Wette was opposed to Schelling's natural philosophy, which broke down the difference between subject and object, that is, between the ego and the non-ego or God and creation, whether in the sense of Schelling's "nature" or Hegel's "mind." [30]

For De Wette, religion was a matter of both individual conscience and of community. In his *Religion und Theologie* (2nd edition, 1821) he lays stress on the idea of religious community, hence recognizing historical as well as psychological and anthropological aspects and thereby giving a new validity or at least a new interpretation to older church doctrines as well as pagan myths. In his lectures on the history of religion he relies heavily on Benjamin Constant's *De la religion considéré dans sa source, ses formes et ses développements*, part of which Ripley was to include in the first volumes of his *Specimens*. He does not reject dogma, nor does he wish it to be regarded as something complete or rigid. He wants the student to see Christianity in its living form, as it developed, not as it is codified, to apply the genetic method to both Biblical and church dogma.

De Wette's contribution in the field of Christian ethics was considerable. For him, ethical laws were not imposed from without but rather something man bears within. About the time of his dismissal from the University of Berlin, or perhaps a little earlier, De Wette underwent a transition from theoretical to practical theology. He was absorbed in the problem of the relation between natural law and Christian dogma. In 1817 and 1818 he had already published essays attempting to analyze the contemporary moral status of politics, science, and art, and to suggest means for improvement. During his stay in Weimar from 1819 to 1822 he began his work on a critical edition of Luther's letters and wrote his novel *Theodor* (to be discussed in some detail below), the story of the development of a young theologian, giving in a sense an account of his own inner history. There was contemporary objection to the mingling of religious and non-religious questions in this novel as well as to specific theological aspects, and the book received a public answer entitled "Die wahre Weihe des Zweiflers,"

[29] Quoted by Heller, E., *The disinherited mind*, chapter on "Burckhardt and Nietzsche," 54, Cambridge (Eng.), Bowes and Bowes, 1952.

[30] For this reason he opposed, though unsuccessfully, the appointment of Hegel at Berlin in favor of Fries.

apparently by the theologian Tholuck. Since the novel was concerned with more than theological controversy and entered the realm of art and ethics, its literary form aroused interest among the laity as well, and the book went into a second edition. De Wette's interest in the theater resulted in an anonymously printed three-act play, *Die Entsagung* (Berlin, 1823).

In this Weimar period De Wette also preached, and considered a call to Braunschweig. While higher authorities in touch with the Prussian government were making difficulties, he accepted instead the proffered chair in theology at Basel. Becoming a Swiss citizen before 1830, he held office on the Board of Education, gave a series of public lectures, helped found a scholarly journal, and presided over the theological faculty. True to his beliefs as indicated in his writings, he could submit to ordination in the Reformed Church (granted by the Church Convention), accept the Basel Confession (1534), and be at home—and remain above friction—in both the Reformed and the Lutheran Churches, again on the basis that religion is a living process more than knowledge of or observance of customs and practices. To him the Church was not a system of concepts but the living community of faith and love. Both at the university and in his public lectures he aimed to declare the truths of Christianity to those whose education resulted in a cleavage between faith and knowledge.

The new theology bore Schleiermacher's name because his technique and language were closer (than the genetic-anthropological approach of De Wette) to the speculative philosophy of the age. But this distinction explains the choice of De Wette over Schleiermacher in Ripley's *Specimens of Foreign Standard Literature*. In his attempt to reconcile science and faith, De Wette's thinking harmonized with the ideal of the New Englanders —the aim of fusing the divine and the human into the true God-man. Like that of the New Englanders, De Wette's theology had a strong anthropological substructure. Like Herder, he approached theology from the human point of view, hence his many connections with philosophy and the arts.

Besides a number of poems, the novel and the play already mentioned, he wrote *Heinrich Melchthal oder Bildung und Gemeinschaft* (Berlin, 1829). This companion novel to *Theodor* traces the life and education of a layman in the light of prevailing scientific and aesthetic opinions. Both novels, as Wolfgang Menzel pointed out,[21] were written in the spirit of Herder—a reasonable, rational, sensible ethics, against both extreme clericalism and pietism, though Menzel objected to the fact that the spokesman for theological wisdom in *Melchthal* is a woman. De Wette's reflective and critical mind did not, however, allow much expression for his poetic and creative faculties. As a critic, he wrote several articles in the field of literature and art, including "Tragic Poetry," "Goethe's *Faust*," and "Painting and Architecture." His interests extended to music, Hebrew (in his last years he took instruction in the *Talmud* from a rabbi), the modern languages, botany, and geology. Although a Swiss citizen, he eagerly followed public affairs in Germany, hoping for its political rebirth in 1848. Liberal in both theology and politics, he warned against the dangers of a liberalism deceived by blind commitment to the doctrine of progress.

II

De Wette's phenomenal reception in New England focuses on four impressive translations of his works for American readers: the novel *Theodor; or, The Skeptic's Conversion* (2 v., 1841), translated by James Freeman Clarke; *Human Life* (a work on ethics, 2 v., 1842), by Samuel Osgood; *Introduction to the Old Testament* (2 v., 1843), by Theodore Parker; *Introduction to the Canonical Books of the New Testament* (1858), translated from the fifth edition, by Frederick Frothingham (all published in Boston). De Wette was known in New England earlier, however, for he had been given wide publicity through Moses Stuart's *Letters to Dr. Channing* in 1819 and 1820. This was not Channing's only contact with De Wette. Margaret Fuller tells in her *Memoirs* of reading De Wette and Herder with Channing one evening a week in the winter of 1836–1837.

In his "Fifth Letter" on the "Mode of Exegesis," republished with the other letters to Channing as the first part of *Miscellanies* in 1846, Stuart attacked what he called violations of interpretation on the part of those professing the Christian religion. There was much less danger, he thought, in outright renunciation of the doctrine of divine inspiration of the Scripture, his reason here being essentially a practical one: the point of contention is much clearer, and the degree of influence is greatly reduced. Most guilty among

[21] *Deutsche Dichtung* 3: 537, Stuttgart, A. Krabbe, 1859.

those promulgating a questionable system of exegesis were the Germans, who "in half a century [have] produced more works on criticism and sacred literature than the world contains besides." He covers briefly the period from Semler, through Eichhorn, Ammon, Thiess, and others, to De Wette, to whom he gives special attention, singling out for criticism his theories concerning the Pentateuch (later origin than had been believed) and his book *De morte Christi expiatoria* (Christ's conscious change from moral teacher to prophet to expiator when he was disappointed by his lack of effectiveness in the two first roles). He then continues:

> Yet De Wette holds a most exalted rank in Germany. I doubt whether Germany can boast of an oriental scholar, or literary man, who has more admirers than De Wette. Gesenius, Professor at Halle, has spoken of him, in a letter recently received, in the highest terms; and selects and recommends him, among all the literati, critics, and orientalists, of Germany, as most deserving of special acquaintance and confidence (p. 182).[32]

By his own and his Andover colleague's correspondence with the Germans, Stuart was functioning as a cultural intermediary, and in his published writings was encouraging further acquaintance with them, although he himself realized "it needs only a moderate acquaintance with German reasoners and critics (a thing which is fast coming in), to induce young men to go with them . . ." (p. 183). Indeed, he is convinced, as was Channing himself, that no one could read the Germans and ever again turn to Priestley, Belsham, Carpenter, Yates, and Lindsey as critics "but with disgust." He admires their erudition, and acknowledges obligations to them, but believes their views to be "fundamentally subversive of Christianity." Stuart recommends them for study, for the good that they offer "in a more scientific manner, and in a better digested and more lucid form than I can elsewhere find" (p. 186). This letter to Channing was an ambivalent plea for the study of German writers. Its primary purpose was to bring theological issues to a head. German theologians were soon widely read in theological and quasi-theological circles, whether of the shade of belief of a Stuart, a Norton, a Channing, or a Ripley.[33] Stuart himself may have read his De Wette all too well, if there is any validity to the remark in George R. Noyes' review of a later work that the Andover professor had chosen the task of proving what had been proved by De Wette and others.[34]

Soon after his statement that neither German theology nor philosophy had received tolerable justice at the hands of English scholars,[35] George Ripley, whom Emerson was recommending to Carlyle that same year as a "very able young man," [36] formulated a plan for the publication of foreign literature, resulting in the fourteen volumes of *Specimens of Foreign Standard Literature* (1838–1842), which Professor Perry Miller recently called an ambitious project "the importance of which has been little appreciated by historians of American culture." [37] He succeeded in interesting some of the younger members of the transcendental group who like him were dissatisfied with the philosophy of experience as represented by the Locke school and were drawn to German philosophy and theology. Ripley assumed a leading role in the controversy that culminated in Andrews Norton's attack upon German thought. It was Ripley who made the public answer, published in Cambridge as three letters on the *Latest Forms of Infidelity* (1839–1840), the last two in reply to Norton's rejoinder to his first letter. These letters contained an enthusiastic account of Schleiermacher and De Wette and a vindication of them as well as of Spinoza, including a correction of Norton's poor translation from De Wette: "a knowledge of German is no merit, but the want of it in those who undertake to expound German theology is an inconvenience." As Weiss remarked in his biography of Theodore Parker, Ripley's thorough knowledge of the subject gave dignity and value to this controversy.

The importance Ripley attached to his plan for a series of translations even before he indulged himself in this direct exchange of views with Norton may be judged by his letter to George Bancroft

[32] Quotations are from the 1846 publication, in *Miscellanies*.

[33] In a postscript written for the 1846 republication, Stuart had the satisfaction of being able to show the trend from Semler through De Wette and others to Strauss, with his idea of "moral romance," and finally to Bruno Bauer, with his charge of fraud.

[34] *Christian Examiner* **40**: 71, January, 1846, a review of Stuart's *Critical history and defence of the Old Testament canon*.

[35] In his review of Marsh's translation of Herder's *Spirit of Hebrew poetry*, in the *Christian Examiner* **18**: 167, May, 1835.

[36] *The correspondence of Carlyle and Emerson*, rev. ed., **1**: 60, Boston and New York, Houghton, Mifflin and Company, 1884.

[37] *The transcendentalists*, 189.

in 1837 in which he wrote that the first two volumes of the series, which were to include the French intermediaries of German philosophy,

> will be strongly tinctured with democratical principles. They will form an admirable counterpart to your political writings. I mean to have them as clear as the morning star; and if they should be read and digested by our democracy—in which is all our hope, . . . [tear in MS] and not how much they be slighted and scorned by our conservative circles, which with his Reverence, the Dean of the Cambridge School at their head, lord it a little too despotically over our American literature. . . . These two volumes of mine will be out in March next; & I feel sure that there are enough who know their value not to let them drop. . . . If these two vols. take to any degree, they will be followed by Schiller and Goethe, translated by J. S. Dwight, with contributions from others as stated. . . .[38]

Six weeks earlier Ripley had commented on the relation between the works he wanted to make available in translation to the American public and Bancroft's *History of the United States.*[39] Prompted by his reading of Bancroft's second volume, he wrote to the author:

> The chapters on the Quakers must of course excite great attention—& if it be comprehended—great opposition, from those who deem the salvation of the world dependent on an outward light, and every appeal to the inborn law a folly & an offence. For my own part, I could not but be pleased with finding such a forcible defence of views, which I have entertained from the moment I understood the import of the philosophical movement in Europe, since the epoch formed by the "Critique of the Pure Reason."

The great problem of modern theology, Ripley thought, was to reconcile religion of the letter and of the spirit, the testimony of doubtful tradition with the voice of God within the human soul. He praised Bancroft's philosophic discrimination evinced in his comparison between Penn and Locke:

> The always ignorant and often petulant idolatry of Locke, which is cherished in our high places of learning, is a dark symptom in the state of culture among us. . . . You have done a good service to the history of philosophy by shewing the identity of the Quaker principles with the vision of Plato, the psychology of Kant's & the modern Eclecticism of France.

Again he dwells on the importance of understanding the connections between the principles of American democracy and the liberal theology:

> It is a cheering sign to perceive the manifestations of a freer & better spirit, among our educated young men of the most promising character, and—strange enough—especially in the clerical profession. Almost to a man, those who shew any marks of genius or intellectual enterprise are philosophical democrats.
>
> New life will be
>
> breathed into the languid veins of our liberal Christianity; & with such men as Brownson, & the brave, young writers in the Western Messenger, I almost hope to see the time, when religion, philosophy & politics will be united in a holy Trinity, for the redemption & blessedness of our social institutions.

Like the editors of the *Western Messenger,* Ripley was fully aware of developments in theology in Germany, and looked to them for substantiations of his own way of thinking in the controversy over miracles that was raging in New England. In a letter published in *The Boston Daily Advertiser* of November 9, 1836,[40] intended as a reply to Andrews Norton's attack on November 5 in that same paper, Ripley underlined the importance of German theology:

> As to modern theologians I need not tell you that it is in the country of Luther, that the science of theology has received its greatest developments, since the time of the Reformation. You are aware that every topic of this science has been discussed there with freedom, learning, and strenuous industry.

Ripley's motivation in planning a series of publications of foreign works is therefore quite clear. He had found in European literature both a wealth of material that should be made available to Americans and a wealth of evidence favoring his side in the theological battle. This second factor explains the religious character of many of the writers chosen, a feature of which both Ripley[41] and the reviewers were aware.

Works actually published in the *Specimens of Foreign Standard Literature* were *Philosophical Miscellanies* (Cousin, Jouffroy, Constant); *Select Minor Poems* (Goethe and Schiller); Eckermann's *Conversations with Goethe*; Jouffroy's *Introduction to Ethics*; Menzel's *German Literature; Songs and Ballads* (Uhland, Körner, Bürger, and other German lyric poets); and the two

[38] Dated Boston, November 6 (1837); MS in Massachusetts Historical Society (quoted by permission).

[39] Boston, September 20, 1837; MS in Massachusetts Historical Society (quoted by permission).

[40] In Miller, *loc. cit.*, 161–162.

[41] *Cf. Specimens* 1: 36–39.

translations from De Wette. But others had been planned:[41a] *Goethe's Correspondence*, a *Life of Goethe*, Fichte's *Destiny of Man*, a *Life of Jean Paul Richter* with selections from his works, *Selected Religious Writings of Herder*, Schelling on the *Philosophy of Art*, *Selections from Lessing*, the theologian Ammon's *Progressive Development of Christianity*, plus one French work, Guizot's *History of Civilization*. A third work by De Wette was also to be included, his *Lectures on the Philosophy of Religion*, which Osgood regarded as the best contemporary account of the history of religion, even superior to Constant's five volumes on the history of the religious principle, to which De Wette had acknowledged indebtedness. The undertaking of the *Specimens* proved to be too ambitious, yet the volumes that were completed form a remarkable achievement.

Four of the ten volumes devoted to German thought contain the two works by De Wette. The first, to be discussed below, was the novel *Theodor* (volumes X and XI). The other was Samuel Osgood's translation of *Human Life; or, Practical Ethics* (volumes XII and XIII), completed in 1841 and published in 1842 "to the memory of Charles Follen." Osgood must have learned much of matters German while he worked with James Freeman Clarke between 1835 and 1837 on the *Western Messenger* in Cincinnati, after completing his studies at Harvard College and in the Divinity School. By 1838 he published a thirty-four page article on De Wette in the *Christian Examiner*,[42] an essay revealing first-hand knowledge of the German theologian. In this article he suggests the reason for the reception De Wette is soon to enjoy in New England, namely, that De Wette, more than any of the German theologians with the possible exception of Herder, was "the most congenial with English readers." He mentions De Wette's pleasing style, common sense, and poetic sensibility. His philosophic sentiment does not lose itself in misty clouds, nor does his scholarly spirit bog down in minutiae. He had been satisfied with neither the forbidding critical system of Kant, the airy ideals of Fichte, nor the pantheism of Schelling. Osgood indicates that De Wette had already become a kind of favorite with English readers, and reports that in Germany the majority of living theologians would rank De Wette as the most distinguished of their number. He is the third of the illustrious trio of Herder, Schleiermacher, and De Wette, and now wears the mantle of the other two. The account Osgood gives of De Wette's life is derived from scattered notices and suggestions from his works. At least by the time he begins the translation, a correspondence is under way, an exchange of letters with De Wette that apparently lasted until the latter's death in 1849.

On the basis of the novel *Theodore* and contributions to the field of ethics, Osgood considered De Wette a guide in matters of taste in music, poetry, and all the fine arts, as well as social behavior. The American saw great similarities in the problems that faced Theodore and many young New Englanders. De Wette's philosophy, he thought, was more modest than other systems prevalent in Germany, having some features of resemblance to the Scotch. Concerning De Wette's important work, *Über die Religion und Theologie* (1821), Osgood wrote that De Wette had combined the critical system of Kant and the philosophy of faith and feeling of Hamann, Jacobi, Fries, and Schleiermacher into the three-fold modes of conviction: knowledge (empirical, mathematical, rational), faith or feeling (instinct of the heart), and sentiment (resignation, devotion, inspiration—the essential elements of religion which are in the soul of man). This German had reconciled the rational and the sentimental schools of moralists, so Osgood later wrote, by making the understanding the means of interpreting sentiment. In 1838 Osgood issued a second article, twenty-three pages in length,[43] on De Wette's views on theology, stressing the principles that would appeal to the more liberal among the Unitarians: that the letter is only the dress of the spirit and that facts are to be valued for the ideas which they contain. Accepting De Wette's explanation of the doctrine of the Trinity as identical with that of the Unitarians (De Wette saw embodied in the Trinity every truth contained in monotheism, anthropomorphism, and pantheism), Osgood did remind his readers that the German found the Unitarian view one-sided and cold.[44]

Osgood did more than anyone to introduce De Wette to New England as a philosophical writer by his translation of the *Lectures on Ethical Science* (1823–1824). On the author's advice, the first

[41a] *Cf. Christian Examiner* **24**: 274, May, 1838.

[42] *Ibid.*, 137–171.

[43] *Ibid.* **25**: 1–23, September, 1838.

[44] Thirty years later Osgood was himself to become what Perry Miller has called one of the casualties of transcendentalism when he left the Unitarian ministry and took orders in the Episcopal Church.

part is condensed in the form of an introduction and the second fully translated. In his preface, Osgood expresses the belief that the work, by presenting a comprehensive and striking view of life in its various duties and relations, must have a practical value even for those who are not in accord with De Wette's theory of morals. De Wette's strong and earnest humanity, his vindication of the essential rights of man, his sympathy with the various sentiments of the human heart, his taste and imagination, his love for freedom, the breadth of his faith unconfined to dogmas and rites, in a word, a religion that "is as expansive as human life," give this work a rare appeal for the audience Osgood had in mind.

A favorable review of *Human Life* called it an admirable companion and successor to Jouffroy's *Survey of Ethical Systems*, and added that it manifested the same "clearness of spirit." [45] Osgood had already complained, in a review [46] of Jouffroy's *Ethics*, which Ripley published in his *Specimens*, that Jouffroy had said too little or nothing of Jacobi, Fries, and Schleiermacher. But De Wette, whose system seemed to him not unlike Jouffroy's, had in several works given a system of ethics more congenial "to our English sense" than that of any other German philosopher. It does justice to every element of human nature, whether passion, will, self-interest, or reason, and has in addition the merit of applying ethical science to Christianity and of giving a philosophical statement of the ethics of the Gospel.

In two further articles in 1840 and 1841 [47] Osgood discusses phases of De Wette's writings in the field of ethics. By 1844 he could report that De Wette was well known in America both as a moralist and, especially through *Theodore*, as a theologian. He credits Theodore Parker with being the first to introduce him as a Biblical critic, referring to the fact that Parker led in translating a complete work in this field. In the article [48] on Parker's translation Osgood praises De Wette especially as a sensitive and penetrating critic of poetry, but is somewhat apprehensive of his liberal doctrinal interpretations as well as of Parker's interpolations. Two further reviews in the *Examiner* [49] stress De Wette's readiness to learn spiritual lessons from passages that contain only symbolic truths, his turning to the essentials of primitive faith in the midst of prevalent critical controversies, his resisting, unlike Strauss, with whom he coincides on some points, the attempt to explain away all supernatural reality. All this adds up to the conclusion that he is "the greatest Biblical scholar of our age." [50]

This enthusiasm for De Wette was shared by Theodore Parker, whose interest in the German theologian probably began in the thirties as a result of his editorial work on the *Scriptural Interpreter*. George Ripley, Frederick Hedge, and Convers Francis may have encouraged Parker to pursue his scholarly work on De Wette's study of the Old Testament. Starting on the American edition in 1836, he published it in 1843. This work, and his interest in German thought resulting from his labors with the translation, led directly to the collecting of his remarkable library of 13,000 volumes,[51] which Thomas Wentworth Higginson in his report to the trustees of the Boston Public Library called "the richest private library in Boston." [52] Parker was attracted to De Wette's theological liberalism and his critical method, which combined historical and exegetical aspects of criticism. He acknowledged his debt to De Wette's historical and critical methods, and despite their differences in conclusions De Wette remained Parker's favorite guide. It was De Wette's view that if Biblical study is treated in the scientific spirit of criticism, historical investigation in theological questions logically follows. The historical study of doctrine became, therefore, a further object of his scholarly activity. Through his critical edition and creditable translation of the De Wette work, regarded as the most important study of his life,[53] Parker was among the first in America

[45] *Christian Examiner* **33**: 253, November, 1842.

[46] *Ibid.* **28**: 137 ff., May, 1840.

[47] *Ibid.* **29**: 153–174, November, 1840; **30**: 145–173, May, 1841. Barnas Sears, editor of the *Christian Review*, had strong reservations with respect to De Wette's following the philosophy of Fries. On some theological questions, however, he too was in agreement with De Wette (*cf.* his review of *Theodore* in **6**: 537–557, 1841).

[48] *Christian Examiner* **35**: 303–311, January, 1844.

[49] Which I believe are Samuel Osgood's, **26**: 285 f., March, 1844; **46**: 326 f., March, 1849.

[50] Osgood later described, in *Appleton's Journal* of 1869 and 1870, some of his personal experiences in Germany and emphasized his admiration for the intellectual standards of the faculty at Berlin.

[51] According to Dirks, J. E., *The critical theology of Theodore Parker*, New York, Columbia Univ. Press, 1948.

[52] *31st annual report of the Boston Public Library*, April 30, 1883. Between 75 and 90 per cent of all books were in foreign languages, including, besides German theology, numerous series in German literature, among others the 150 volumes of the *Bibliothek des literarischen Vereins in Stuttgart*.

[53] *Cf.* Chadwick, J. W., *Life of Theodore Parker*, 51, Boston and New York, Houghton Mifflin and Company, 1901.

to understand Biblical criticism as a field of scientific inquiry. He has been seen as a transitional figure who relied on scholars representing the "mediating" school in Germany, to which De Wette and Schleiermacher belonged, as opposed to the extremes of both orthodoxy and rationalism. He mediated between the critical approach or scientific inquiry and the emphasis on human consciousness characteristic of the transcendentalists, and thereby plays a role in the shift from enlightenment to transcendentalism.

Parker's preoccupation with De Wette is one factor in the intensification and broadening of his German reading. He did not think that any new observation had been made or any general law discovered in his field by any French or English theologian of his century. Germany, "par eminence the land of theological books," he regarded as "the new East out of which the star of Hope is to rise." [54] Hence an antagonistic reviewer of his *Discourse of Matters pertaining to Religion* (1842) could decry Parker's "terrible array of German artillery." [55] De Wette's critical approach probably contributed to Parker's acceptance of some of the findings of more extreme scholars, as for example a Strauss or even a Bauer, so that in his famous 1841 sermon on "The Transient and Permanent in Christianity" he could say, ". . . modern criticism is fast breaking to pieces this idol which men have made out of the Scripture." Least of the labor expended on the De Wette text was the translation itself. Parker did not hesitate to make interpolations, both of his own and of borrowings from other German sources, thus adding or enlarging individual sections. But the work was made more valuable by the additions, according to Osgood, who praised the idiomatic English and the adherence to the spirit of the original, at the same time criticizing the excessively liberal interpretation of both De Wette and Parker and the want of greater regard for the unity of revelation. Fifteen years later the translation was still commended as Parker's most complete critical work, one held in high esteem by scholars. A reviewer of the third edition (the second having appeared in 1850) extols the original German author's patience, candor, and learning, adding, "his work is much the most serviceable that exists." [56]

Soon after the publication of the first edition, Parker had an opportunity to see De Wette in Basel, a visit described in a letter in 1844 to Convers Francis, his friend and mentor in German culture and senior member of the New England Transcendental Club. Parker's account gives many glimpses of De Wette and the life he had accepted at the modest University of Basel in exchange for his distinguished position at a more illustrious university:

> At Bâle, of course I saw De Wette, a compact little man with a rather dry face, a little irritable, I fancy, perhaps something soured by his long disasters. He had not received the copy of my translation which Mr. Brown was to send him. This grieved me much. He is preparing a new edition still, but with no considerable alterations from the last. It will soon appear. During the last time I stayed at Bâle, I saw a good deal of him, first and last, heard him lecture, &c., spent an evening with him at a friend's—his wife is away—dined with him at his son's. His functions are not great; he has from twelve to twenty students of theology, and the whole University at Bâle numbers but about sixty pupils! You may fancy that De Wette spends his time more agreeably in the study than elsewhere. But then he has leisure enough to write, and think, and speculate, and print, too. He knew but little of ecclesiastic affairs or theological matters with us. He only knew Norton as one that polemized against him. The light of the seven gold candlesticks, on the back of the academical lectures, had never gladdened his eye. Even Grey's Key was known only by name. Wouldn't it be a good plan for the "Body," as Father Briggs says, to send out—with a lot of Grey's Keys to enlighten the Germans withal? Some of "our excellent tracts" might also be circulated to advantage. Pray suggest it. Who knows but it may stay the flood of Rationalism which threatens to leave sundry dogmas where Grotius says the Ark may still be seen?
>
> I heard De Wette lecture on the Harmony of the New Testament. He cut right and left and made no bones of saying that such a passage was probably unächt (spurious), that John knew nothing of it, &c. "Carpenter's Harmony" would set the Professor right on this point.
>
> I cannot tell you all the thousand things we talked about in Bâle, theological and philosophical. Of these at home. Last year or earlier he went to Halle and Jena, and was received with great enthusiasm by the professors and students at Jena, he made a speech to them, and advised them to *study their books*, get their lessons, and keep silent. So some one told me, which advice they will keep as well as George Fox the similar advice which some one gave him; but it takes a great deal of soul to bear up well under exile and long misfortune. Yet De Wette has never retracted ungenerously anything he has said. The good men, says Ewald, justified him in all his course at the time of his exile, but the journals never dared say one

[54] Parker, Theodore, Thoughts on theology, *The Dial* **2**: 485–528, April, 1842.

[55] *Christian Examiner* **32**: 394, July, 1842.

[56] *Ibid.* **65**: 125–126, January, 1859.

word in his defence. I think he is a great and noble man. Perhaps no theologian in Germany has more influence at this moment than he. He is both critical and mystical, so seems sometimes to waver, and does lean as one or the other element gets the upper hand.[57]

Parker's travels in Germany acquainted him with other notables, among them Bettina von Arnim, who read to him from her own work. One month after the letter just quoted Parker wrote about this meeting to Dr. Francis, who would have special interest in the matter since his sister was at the time in correspondence with Bettina. In Heidelberg Parker talked with Paulus about German theology, and reported that Schelling had tried to have Paulus' book on Schelling suppressed. From Ewald in Tübingen he heard enthusiastic approval of his having undertaken the task of translating De Wette for the Americans. Parker continued to correspond with De Wette and other acquaintances abroad, and hence should not have been as surprised as he was that so many people loved him "not only in New England, but in old England and also in Germany," as he wrote from Europe the year of his death, 1859. In his recollections written that same year he could say that the German language, "hitherto the priceless treasure of a few," had become well known and that a storehouse of the "most original, deep, bold, comprehensive, and wealthy literature in the world, full of theologic and philosophic thought," had been opened to many.[58] Parker's translation of De Wette is a major element in his contribution to the dissemination of German thought in New England. The influence of the German "mediating" school left its mark on all of his writings.

Another important work of De Wette's in the field of Biblical criticism was his *Introduction to the New Testament*, the fifth German edition of which was translated by Frederick Frothingham and published in 1858. This work, too, was considered, as a reviewer pointed out,[59] the best of its kind. Frothingham had spent several years in Germany, where he increased his knowledge of German and enhanced his familiarity with German theology. Frederick was not the only one in his family who was concerned with German writings. Nathaniel L. Frothingham wrote a number of reviews of German literary figures, including Herder,[60] Schiller, and Jean Paul; in theology he was drawn to comment on Herder, Schleiermacher, and De Wette for New England periodicals. De Wette's son sent N. L. Frothingham an inscribed copy of Hagenbach's address at De Wette's funeral, which the recipient later presented to the Harvard Library. O. B. Frothingham, in his writings covering many phases of German influence, also did not fail to mention De Wette.

Frederick Frothingham's translation came out shortly after the appearance in 1856 of the second editions of Osgood's and Clarke's translations. Thus, there were two peaks in the publication of De Wette in America, one in the beginning forties, the second a decade and a half later. Although the second may be regarded in the main as an echo of the first, it indicates the persistence of an interest which even extended into the seventies with a third printing of *Human Life* and *Theodore*.

Left for final discussion in this study is *Theodore; or, the Skeptic's Conversion*, which gave the most comprehensive survey of De Wette's ideas and had the widest appeal to readers. Published in 1841, the impressive translation by James Freeman Clarke was begun at least by 1836, when the first serial installment appeared in the first volume of Clarke's *Western Messenger*, in Cincinnati, other selections following in 1837 and 1838. With the subtitle "History of the Culture of a Protestant Clergyman," the work was then published in its entirety in Ripley's series. It is the most significant of that group of De Wette's writings which may be called literary, though their purpose was primarily to expound and elucidate theological problems. Of De Wette's attempts at creative writing, the New Englanders knew only *Theodore* and the poems interspersed in it, but in this novel American readers found an easily digestible account of a subject of great concern to many of them, namely, contemporary trends in German thought.

Clarke's preface to the translation announces his purpose of making available a sample of the German theological writings that at the time were creating such a stir in America. He saw great similarities in the problems that faced Theodore and the young New Englanders. And this work, written in Weimar (1st ed., 1822; 2nd ed., 1828),

[57] In Weiss, John, *Life and correspondence of Theodore Parker* 1: 244–245, New York, D. Appleton and Company, 1864.

[58] In Miller, *loc. cit.*, 488.

[59] *Christian Examiner* **65**: 140, July, 1858.

[60] He translated Herder's letters, according to Frothingham, O. B., Some phases of idealism in New England, *Atlantic Monthly* **52**: 14, July, 1883.

gave in the agreeable form of romance, views on literature, art, morals and mores. It was both a source of information and an example of a philosophic mind struggling through the many phases of speculation and doubt—a case of liberal Christianity framed in fiction. Only in the writings of German theologians, Clarke avers, could one find fresh views of the essence and spirit of religion and profound scholarship in criticism, philology, and church history. He extols the life, freedom, and depth of the German mind that contributed to the preeminence of German theology. Although his translator realized De Wette's lack of certain qualities desirable in any form of literary writing, he saw the author of *Theodore* as a central figure in the current tendencies in German theology and a leading conveyer of German thought. In the light of the American interest in De Wette already evident, Clarke thought no other work of his could more adequately give a general view of De Wette's opinions on philosophy and theology. He also believed that such a book would clarify some of the issues focusing on the transcendental movement as well as calm some of the alarms aroused by other excursions into German material.[61]

De Wette, in his own preface to the second edition of Clarke's translation, states that he had never sought credit as an artist. His sole purpose was to demonstrate that the skepticism produced by narrow and shallow study could be removed by more profound examination. And in a letter included in the preface to the American edition, De Wette wrote to Clarke that he had aimed to give in a freer and more attractive form than a scientific treatise the view of Christianity he considered most valid. He tells of having been under the influence of Schelling, the two Schlegels, and Schleiermacher, and of his search for a theology that "gave more play to the imagination, and more food to the heart, and which shrunk from the coldness of a merely intellectual system," a theology striving for the reconciliation of faith and reason. His purpose in the novel was always to be a mediator between extremes. Detecting a corresponding social tendency for every religious tendency of his time, and stressing the importance of community and a common spirit, he related poetry and art to religion. Among the analogies between literature and theology, he mentions the dramatic school of Iffland and Kotzebue as corresponding to the theological school of rationalism and the works of Goethe and Schiller to a more transcendental trend in theology. Simultaneously with Theodore's religious development through rationalism, supernaturalism, mysticism, and a leaning toward Catholicism, his views on poetry and art develop or change. In the preface to the American edition, De Wette refers to his own system as critical-aesthetic, a system of which he believed himself to be the lone supporter in the late thirties.

As a student of philosophy—his initial appointment at Heidelberg was in this field—De Wette had been forced to come to grips with the rigid moral code of Kant and the naturalism of Schelling, the predominant philosophical trends of his time. Schelling's God, who in order to become acquainted with Himself must be shed abroad in creation and in eternal change be destroyed and produced anew, was for De Wette not God but only the constantly renewed life of nature:

> If all is from and in God, and every thing can be carried back into the same ideality; if the absolute, which appears in all things, is necessarily what it is; and if every thing which now exists belongs to its essence;—then vanishes all distinction between good and bad; nothing is imperfect in the world; every thing is sanctified by God,[62] or rather he is desecrated by imperfection (p. 59 [63]).

The idea of a divine will above all change is thereby lost, and freedom is cancelled out, since everything, including God, is subject to necessity. De Wette has Theodore study under a professor of philosophy—Fries, to whom De Wette felt philosophically indebted—who held a middle place between Schelling and Kant and attempted to reconcile the two. Fries' scheme presupposes a primal consciousness—faith—as belonging to the human mind (Schelling's "intellectual perception") and tries to show how this primal consciousness is unfolded into a variety of spiritual faculties and how the whole framework of human knowl-

[61] Clarke's own indebtedness to De Wette has already been pointed out. *Cf.* Thomas, J. W., *James Freeman Clarke, apostle of German culture to America*, 96f., Boston, J. W. Luce, 1949. *Theodore* very probably inspired Clarke's own religious novel, *Thomas Didymus*, 1881, which he first intended to publish as a translation from the German. After a correspondence covering a number of years, Clarke on his visit to Europe in 1849 went to Basel but arrived just after De Wette's death.

[62] The influence of German idealism on such New England spiritual movements as Christian Science has not been sufficiently explored.

[63] All page references are to the 1841 edition of *Theodore; or, the skeptic's conversion*, Boston, Hilliard, Gray, and Company.

edge and experience is based on their commingling, through which a world, situated in time and space and subject to the laws of nature, is exhibited to the mind. But—and here is the return to Kant—this knowledge is only an imperfect copy of the essence of things, of which the archetypes lie hidden in the primal consciousness. Faith, or Kant's intuition, becomes the only source by which the world can appear as a harmonious whole. Knowledge alone does not lead to full understanding of the world. Only feeling and love give things their living meaning. And action completes the certainty of knowledge and feeling. The dependence and limitations of the human intellect are acknowledged, and the point fixed where it connects itself with the knowledge of things in their essences. To an extent, the absorption of the particular being in universal being is allowed, but without cancelling out personal existence. By its faculty of faith, the soul possesses a supernatural knowledge above the transitory nature of the world of experience, and thus cannot itself be of a transitory nature.

The reconciliation of reason with faith is made possible by ascribing a kind of faith to reason. Hence Kant's understanding, the lower faculty of knowledge, alone can be in conflict with "revelation." De Wette's conception of revelation was of special interest to his New England readers, since this was closely related to the core of their theological controversy. Inward revelation he places in the reason. It is the "last, unconditioned ground of reason. . . . The inward revelation is to our knowledge what God is to the outward world. Revelation is our inward God, in which we believe, from which our mind receives life and light" (pp. 79–80). When expressing his opinions regarding the connection between external or historical revelation to the internal or natural, he gives the impression made on him—and on Theodore—by the performance of Schiller's *Maid of Orleans*, which is thus established as a source of his views. Internal and external revelation have the same origin, namely, the human soul, in that supernatural knowledge which he calls faith. The internal revelation is faith itself. External revelation is a special expression of it. In the inspired person the divine spark that exists in all minds

> is not quenched and buried, but is fanned into a flame. This heavenly fire strengthens and illuminates all the lower faculties: the will obeys no longer the passions, but only the inward, heavenly impulse; the understanding receives the godlike light in a pure and unclouded ray, and is not misled by the perplexities of sensual knowledge. In such a mind, human reason is transfigured to the divine reason; or, if you choose, it is brought back to its original purity and perfection; its archetype, grown confused and deformed, comes up again distinct and clear. The seat of all error and immorality is the understanding; which, as the faculty of voluntary consciousness, may substitute, in the place of the pure archetype, a false conception of its own (pp. 94–95).

De Wette uses Schiller's play, therefore, to demonstrate at once Kant's distinction of reason and understanding and the contemporary theological application of this philosophic distinction. Clarke feels constrained to underline this passage by paraphrasing it in a footnote in which he says, among other things, that the function of the understanding is not to see truth but to show the relations of knowledge. Its function is to analyze, compare, infer, systematize. Acting freely in these processes, the understanding is liable to error. Goethe's organic whole, or rather Friedrich Schlegel's version of it, can be destroyed by analysis, by the conscious mind. Consequently the unconscious mind is superior.

In the application of *The Maid of Orleans* to the question of external or historical revelation De Wette also analyzed what the "image" can do and indeed what "image" means to him in literary and philosophic terms. For when the Kantian reason manifests itself in words and actions, others are forced to discover in it the image of that archetype which resides in all minds. If people recognize in it the truth and goodness of God, they have an external revelation of Him. Thus any person in whom the divine principle predominates over the human is a kind of mediator. This manifestation is more by actions than by words, "for the whole man appears in his action, in which feeling, knowledge and active energy are united" (p. 99). The feelings are more directly affected by the sight of an action than by the sound of words. The image may lead to misunderstanding, as it did Joan of Arc, according to De Wette, when she believed herself to have received inspiration from the Virgin Mary. But the worship of the Virgin contains a degree of truth. Joan did not err in thinking herself inspired by a lofty spirit. "Her pure and humble soul, abstracted from earthly things, lost in contemplation, was kindled by the divine sparks which slumber in every human mind" (p. 89). Of special interest to the student of Schiller is Theodore's rejection of

any implication that the love of the sexes is impure. If the human mind is incapable of loving with equal intensity and at the same time two objects, then Joan's love for Lionel must weaken her patriotic ardor. Feeling, in this case love for a nation, can direct the will. For De Wette, feeling is at the very root of the moral law, a prime difference from Kant's system of ethics, which had no place for feeling and which, destitute of warmth and life, belonged to the realm of the understanding rather than to higher reason or faith.

The most lasting influence on Theodore—and De Wette—was Schleiermacher, especially his *Discourses on Religion*, which attempted to define religion and its connections with intellectual and moral life. The book gave him the key to the relation of religion to morality, science, and art. "Science is the existence of things in our reason; art is our existence in the proportion and forms of things" (p. 162). Only as our minds become one with nature, when the finite and the infinite meet, can we begin to possess science and art. Schleiermacher regards the union of the finite and the infinite as the essence of religion. This union he locates in the feeling, placing religious science in the intellect and morality in action. By religious feeling man comes in touch with the infinite, by knowledge and action with the living world. Neither rationalism nor supernaturalism can have any meaning for Theodore, restricted as they are to doctrines, dogmas, abstract ideas. Living feeling, originality of feeling and thought (originality in the sense that the individual himself has the experience), means little to the rationalist, while the supernaturalist has renounced his powers of mind.

On the subject of miracles, the central issue in the New England theological struggles of the thirties, Theodore, who cannot regard a miracle as anything in violation of the laws of nature, could give support to Ripley, Parker, and Clarke. In part exaggeration, the miracles are for him the results of a higher knowledge on Christ's part and confidence on the part of those who experienced or beheld them. Since the miracles are seldom reported with historical exactness, they must have been intended more for their moral significance. The writer's view of their meaning, rather than the outward shell, was what mattered. De Wette laid great stress on symbolic meaning. Indeed, he believed that full harmony between symbolic significance and the historical or moral truth of Christianity established rather than destroyed the essence of Christianity, for its true essence lay in faith or feeling, from which proceeded "truth for the intellect, goodness for the active powers, and beauty for the aesthetic sense" (p. 242).

De Wette's system presupposes the existence of God in the world no less than above the world. The divine spark in every human being is not nullified by the doctrine that God is the cause and source of all man's power. Man's feeling of confidence derives less from mere observation than from active participation in creation, in the rich treasures of life that flow from the inner fountain in the human soul. The problem, therefore, of external revelation, as conceived by the orthodox and the supernaturalists in Germany or in New England, is seen in a completely different light. The Bible is a testimony of faith and not a source for scientific knowledge. De Wette clearly distinguished between the two domains, and decried the restrictions placed by the literalists on personal thought and independent inquiry in the domain of factual knowledge. He challenged both distrust of the power of the human mind and the presumption of the possession of factual truth on the basis of literal interpretation of ancient documents.

In Biblical criticism itself, in which field De Wette excelled, he valued more the intellectual striving and the influence it exercised on the spiritual condition of the church than the literal results of its investigations: "Its duty is to keep the intellect awake, that it may not yield itself to a hasty fancy, or an easy credulity" (II, 196). The intellect has its limits, but ought always to remain active within those limits. While the intellect was no substitute for the essence of religion which was in feeling or faith, the absence of a free scientific spirit in any theology was offensive to De Wette. The following words had special meaning for the liberals of New England:

> Is, then, the system of Calvin, however highly we may prize it as a monument of his faith and intellectual acuteness,—is it the sum of all Christian knowledge? Has the Holy Scripture been exhausted by him, so that it is now unnecessary to look into it and search it with a free mind? Has not this theology the stamp of the age in which it originated? And shall this stamp be impressed upon ours, which, in many particulars, has become so different? (II, 58–59).

Though admitting that much error and confusion may have resulted from the variety of theological thought in his time and country, he commended

the intensity of intellectual activity in the realm of spiritual culture in Germany, the search for truth, the desire to educate, the devotion to poetic and artistic beauty. This receptive spirit was not easily found elsewhere, he believed. Many New Englanders were soon to be making similar statements.

Art was closely related to religion, for De Wette, and on two levels. A basic tie in his "critical-aesthetic" system was symbolism and its function. The other connection was the appeal to human sensibilities in both religion and art. Through his approach to many of the scriptural documents as poetic statements of faith as well as his own predilection for belles lettres, De Wette applied his critical faculties, gaining help from the aesthetic theories of his day, to the function and meaning of literature. Just as he had first sought the moral element alone in theology, so he had conceived the thought, the sentiment, the emotion as the essence of beauty. But through his study of aesthetics his attention was directed to the "poetic form of the whole," which alone gives value to a work of art and through which it becomes an image of the universe. Turning his attention from Schiller to Goethe, he reread the latter's works numerous times in order to find the meaning of poetic form. He realized, at the very time Iffland and Kotzebue were still at the height of their popularity, that pathos was not a triumph of poetic art. The aim of poetry was not to move strongly, to give a moral stimulant, but rather to give regard to the harmonious proportions of the emotions which the poet excites. Iffland's *Hagestolz*, in which the author assumes the role of a moral teacher, aims to give an unfavorable impression of unmarried life, but for the poet, according to *Theodore*, it should be a matter of indifference whether his protagonist is married or not. Marriage and bachelorhood are situations which may each reveal aspects of human experience. Life in its inmost depth and peculiarities should be exposed, and in a way that lifts the spectator or reader to a height from which he may impersonally—and even cheerfully—view the whole scene.

The artist, although inspired, must in like manner remain a master of his inspiration. Pure aesthetic creation or pleasure is possible only when conflict with personal interests is excluded. Choosing *Joan of Montfaucon* as an example of Kotzebue's work, De Wette's hero charges this play with extravagance and calculation for effect. The spirit of morality may animate but not dominate art whose goal is living beings, not moral machines. Nor does he approve of rigid categorizing of good and evil. Rather he recommends a free mixture of the two, since the contrast is to a large degree in man's conscience and not in the external world. The poet should not anticipate moral answers or predetermine contrasts of good and bad, but leave these judgments free, exhibiting the general and free law of life as it lives in all human convictions. In Goethe one may see how a poet can be moral without breaking artistic unity by tedious moralizing. Since the judgment of good and evil, belonging as it does to the moral understanding, will depend to some degree on the individual, it is not suited for poetry, which requires free judgment. The moral judgment is confining, whereas poetry should take us out of and above ourselves. Obviously echoing Schiller's theories and polarities, Theodore states that the highest beauty derives from a perfect unity of body and spirit, of innocence and knowledge, simplicity and richness, humility and courage, seriousness and cheerfulness. Art which merely excites reflection or arouses action may fail to partake finally of the nature of the beautiful. But when pleasant to the contemplation or when satisfying in itself by harmonious proportions giving inward delight, the work of art has through form attained beauty. Variety is characteristic of all phenomena, but when variety is welded into a unity, appearance becomes beautiful. This unity is beyond that of plan, purpose, or design, which merely satisfies the understanding through the adaptation of means to ends, but of a higher kind that acts on feeling rather than the understanding.

Like Schiller the aesthetician, De Wette held that whatever pleases in the view of human actions and sentiments, whatever entertains and delights in the representation of human character in art, is always a quality of the soul. And though he did not as clearly distinguish grace from the sublime as did Schiller, he also believed that without the aesthetic contrast of beauty and deformity, of good and evil, beauty itself cannot exist. If evil or deformity is given a degree of character and power, they too partake of the nature of goodness and beauty. Ethical beauty and natural beauty have a common basis in that both are manifestations of life. While he does not neglect to suggest that the material the artist chooses should be "pure," De Wette is nevertheless "modern" when he says that beauty arises principally from form:

What is there in a drop of water, in itself, to gratify the sense of beauty? But when drops of water unite in a stream, it attracts the eye by its calm and clear flow. And when it plunges, as here, from rocks, so as to represent to the eye an animated play, full of form,—a bravely leaping bow, a dance of foaming waves,—when the material, insignificant in itself, becomes, as it were, alive, and full of splendor from its manifold forms,—then we see the full manifestation of beauty. Beauty is life. But life is in form—in the free, harmonious connection of the material . . . (II, 159–160).

Again like Schiller, De Wette ascribed a crucial role to art in the life of man. The chief aim of art is to educate the moral sensibilities, man's moral nature, to be a "ministering servant at the shrine of holiness and religion." Like Novalis in Germany and Channing in New England, De Wette maintained that the art of a nation must be deeply rooted in its culture, particularly in its religion. The artist is not wholly free in the choice of subject but should seek inspiration in the culture known to his audience. Penetrated by the spirit of a people, a national art can in turn influence that spirit. Poetry sometimes anticipates life and often loiters after life, but poetry and life exercise a mutual influence upon each other. True art must partake of a popular character, that is, it dwells, as among the Greeks, in the life and manners of the people as well as in "the burning words of the bard." At one time it was "a flower which bloomed wild over the fruitful native soil, while with us it is artificially raised in gardens and hot-houses" (I, 230). This whole section of *Theodore* must have had particular relevance to contemporary American pleaders for a native literature.

The essence of the aesthetic is expression directed to the feelings of a people, but this expression which moves the soul does so by the perception of beauty. From Schleiermacher De Wette accepts the notion that the world of aesthetics is joined to religion as the latter's organ of manifestation, the idea that the beautiful is a manifestation of the good. Aesthetic symbols are a means of expressing the religious sentiment. Since the essence of religion is feeling, it can be expressed only imperfectly and to a limited degree. Even less can it be restricted to doctrines and dogmas. The most suitable means of expressing religious sentiments is, then, in poetry and other arts. These give suggestions and images where the real and the final belonging to religion cannot be expressed. Every poem or work of art is, for De Wette, a religious symbol in that it gives us a sensible image of that which sustains the world, and is an image in miniature of the harmonious order of the universe. De Wette speaks of two kinds of religious symbols: mythology, a representation of the supernatural world by means of arbitrary characters, and symbolism, the sacred emblems and usages peculiar to religion. The latter presupposes an equipoise between form and substance, the free aesthetic form. Not that religious symbols without religious life have much meaning. For Theodore, faith, the religious community, as well as religious symbolism are based on feeling, and hence in a sense related.

Every poetic image and work of art is a symbol. In the transference of spiritual truths from the doctrinal to the symbolic, De Wette saw two advantages. First, the incomprehensible can be saved from a misleading spelling out and, second, feeling is given a greater chance for warmth and life:

> It may be stated, as a general rule, that the symbolical view begins where the historical ends; and the former is the summit and the flower of the latter. The substance of the story belongs to history, its spirit to symbols. When the substance has been examined and harmonized, it becomes the object of symbolical contemplation. The history of Christ's passion, for instance, is treated historically when the facts are critically investigated, and placed in their actual relation to each other; it is symbolically treated when we see in it the eternal or ideal story of the war which good must wage with evil, the spirit with the flesh, and the perfection and glorifying of our human nature. There are points, too, where history reaches its limits, and seems to tread on the verge of the supernatural world . . . and here the symbolic view alone must take its place (I, 246).

When doctrine is insisted upon, the aesthetic view becomes subordinate to the intellectual, a defect—the preponderance of thinking over feeling and the want of the poetic in religious life—which De Wette saw in the Protestant church. For that reason he made his true representative of female piety, in *Theodore*, a Catholic, since most Protestant women at that time were either "cold Rationalists and moralizers or gloomy and austere Pietists." For him the ideal of piety included the imaginative and poetic, aesthetic attributes that helped account for the trend toward Catholicism in Germany in the first decades of the nineteenth century. Superstition must be opposed and under-

standing advanced, but there are "holy places which must always remain veiled in reverential obscurity" (I, 273). The true form of religious expression, he had learned from Schleiermacher, was not in statements of fact but in the symbol or image of that which transcends factual knowledge. Underlying De Wette's attitude or approach, is the assumption that a rational view, in its proper light, is not in inner conflict with the religious view. Free research must continue, but be united with a symbolic retention of doctrine.[64] Religion, like art and love, has archetypes in imagery and belongs to the imponderable.

Theodore; or, the Skeptic's Conversion, though significant for its treatise on the problems of faith and for the aesthetic issues it posed for New England readers, does not live as fiction. The style is easy and lucid, certainly for a theologian of the period. Yet the characters seldom escape their author's didactic intentions. They remain mouthpieces or pawns in a game of dialectics. With all its analyses of the role of feeling in art and religion, the book sets up human relationships singularly lacking in emotional vibration. The impact of effective fiction is missing. Ironically, the best criticism of *Theodore* is written into the novel itself in De Wette's penetrating theories on the ultimate artistic failure of moralizing and abstraction unless cast into moving images. On the other hand, the story does demonstrate a degree of poetic sensitivity and a profound respect for the role of literary creation, which explain the author's reputation in his day as a first-rate interpreter of religious poetry. As Samuel Osgood stated in his article on Parker and De Wette,[65] the latter was admirably fitted for the office of critic of poetry in all its forms. Understanding the impulse of the poet, he added a dimension to Biblical criticism as much in his approach to the poet as to the prophet. In his writings on the Psalms, his views on the rhythms of the lyrics have the merit of originality. Theodore Parker was especially impressed with De Wette's characterization of the Pentateuch as the Hebrew national epos.[66]

From the vantage of cultural history, *Theodore* is an exceptional work, a narrative which reads as well as can be expected in a combination with the skillfully manipulated texture of complex ideas on philosophy, religion, art, and social conditions. In palatable form De Wette offered both a digest of contemporary German thought and a blueprint for cultural progress.

III

Cultural progress, the improvement of both the individual and the community, was a key-word to the New England Transcendentalists. Whether their attachment to the literature of Germany was a cause or only an effect (as Orestes Brownson maintained), concern for the theological questions inextricably bound up with New England intellectual activities was a primary motivating force in turning their minds to Germany. The peculiar task of the theology of the first half of the nineteenth century, in Germany as in New England, was the problem of harmonizing reason and faith, nature and mind, God's word in creation and God's word in revelation. The path by which many came to the idealism of Goethe and Schiller, or Kant and Schelling, was theology. And of the German theologians none, not even Herder or Schleiermacher, was accorded the reception given De Wette.

The reasons for De Wette's becoming so well known in New England may be summarized as follows, no one answer being sufficient in itself:

1. The particular theological complexion of New England at that time, with a large group for whom trends in German thought were made to order. Many New Englanders were on the point of floundering on the issue of revelation and miracles, and De Wette offered not only a means of reconciling reason and faith, but demonstrated that he could maintain his faith within the established church, whether Lutheran or Reformed.

2. The intellectual bent and explorations of the New Englanders. Nowhere did they find greater inspiration or information in Biblical criticism and other areas of theology than in Germany. There they met a highly developed combination of intellectual pursuits and dedication to religion—the use of the critical method and the retention of the basic ideas of Christianity.

3. De Wette's form of liberal theology. He was a moderate in his philosophic and theological views, and represented a balance between Kant and Schelling, between the rationalists and the

[64] This aspect of De Wette's thought is discussed in an excellent long essay by Schenkel, D., *W. M. L. De Wette und die Bedeutung seiner Theologie für unsere Zeit*, 1849. The copy in the Boston Public Library, once owned by Theodore Parker, has that part checked which indicates De Wette's attitude toward the Bible as a product of human endeavor rather than a supernatural book or an object of mockery on the part of freethinkers.

[65] *Christian Examiner* **35**: 303–311, January, 1844.

[66] *Cf.* letter to Convers Francis, March 10, 1840; MS in Boston Public Library.

supernaturalists, the orthodox and the liberal. He both sustained his New England readers in their aims and was a vehicle for the information they sought. Balance, moderation, reasonableness were attributes that they missed in many other German writers. In connection with De Wette's liberalism, it should perhaps not be overlooked that he was also a liberal in politics, devoted to public affairs, opposed to distinction of rank, and willing publicly to oppose authority for his ideals.

4. The particular quality of De Wette's work, his balance in spirit and style as well as in substance. He was readable from the point of view of the educated layman as well as of the scholar or specialist.

5. The personal mediation of Charles Follen and Charles Beck.

Encouraging many of the leading intellectuals of New England in their attempts to form meaningful concepts, De Wette's work was the basis of Theodore Parker's greatest single achievement in scholarship. On Ripley, De Wette's effect was immeasurable. Clarke, Osgood, and even Norton, the leader of the opposition to German thought, were profoundly affected by this German theologian. And Emerson, who regarded Unitarianism as being at once too coldly rational and not rational enough, may have found some comfort in De Wette, to whom Clarke referred in a letter to Emerson as a recognized standard of theological excellence. To other New Englanders interest in De Wette brought a fresh knowledge of German literature, since repeated American editions of his writings included his fiction, which grappled with problems of aesthetics. Interest in German literature was often a by-product of theological concern. Through his offerings in both areas, De Wette quickened American study of another culture.

SOME INDUSTRIAL VITAMINS

ZAY JEFFRIES

Vice-President (ret.), General Electric Company

(*Read April 24, 1958*)

DR. EDWIN G. CONKLIN, our revered past president, eloquently called attention to a rough analogy between the human nervous system and the telephone and telegraph. Others have shown general similarity between the functioning of our bodies and industrial plants. We take in fuel as food and burn part of it in a complicated way with the air we breathe. Other fractions of our food supply the raw materials of construction for bone, fibre, muscle, etc. The manner in which these raw materials are transformed and transported to produce the end result involves chemical processing more advanced than man has been able to duplicate in the most modern industrial plants. Nevertheless, there is a rough analogy. Still other rough comparisons have been made with respect to our senses. Man has the capability of recording colored, sound, moving pictures and even changing sensations, and playing them back at will, without benefit of projector, screen, or light. Even if the recording is not quite as accurate as a tape or film and even if the play-back is often confused we will perhaps agree that the feat is remarkable.

Today I wish to remind you of another rough analogy. We hear much these days about enzymes, hormones, vitamins, catalysts, and trace elements. We will permit the specialists to distinguish among these because I am interested today merely in the fact that each produces large effects in small amounts and in some cases a deficiency results in health impairment. So I will refer to a few items in industry which produce large effects in small amounts and deficiencies, in some of which, cause impairment in our industrial health. For convenience I am calling these materials, "industrial vitamins."

Although many materials, organic, inorganic, metallic, or non-metallic could be selected as illustrations, being a metallurgist, I am so keenly aware of nature's shortcomings in the use of metals in the construction of man that I am going to use, as examples, three metallic elements. These are manganese, tungsten, and germanium.

We should, however, pause here to note how man has marvelously improved on nature in the use of metals. The metallic fillings in some of our teeth are now integral parts of our bodies. In addition, some people have tantalum, silver, titanium, or the metallic cobalt alloy, vitallium, as integral parts of their bodies, including skull plates, joints, tubes, sutures, bone parts, and other internal support members. Notwithstanding the fact that some of these parts are much more durable than the ones for which they are substituting, nature did a reasonably good job considering that she had to do everything without benefit of metals.

The three materials mentioned are classified as "minor" metals. Manganese is consumed in the United States on the order of a few hundred thousand tons per year and it has been important for around a hundred years. Tungsten is used in this country in amounts of a few thousand tons per year and its important industrial history dates back a little more than fifty years. A few tens of tons of germanium per year take care of our requirements and its important use began only about fifteen years ago.

Now let us consider these materials a little more in detail. Manganese is sufficiently abundant in the earth's crust to take care of all of man's needs, but the United States, or for that matter, North America, is deficient in the higher grade ores. These are found in Russia, Africa, South America, and India in substantial amounts and in lesser amounts in many places. By utilizing low grade materials, considered now as uneconomic, we could provide our requirements in an emergency, at a cost, but stockpiling, in case of a possible blockade, is a sure way to guard against a potential temporary shortage. The ores are processed to make various manganese-enriched products such as ferro-manganese for industrial use.

Although manganese has many uses the main consumption is in connection with the steel industry. In finished steel, manganese in small amounts,

say 1.5 per cent and lower, improves certain properties and in addition promotes "deep hardening" on heat treatment. When added to steel in amounts of around 12 per cent, a special steel known as manganese steel is produced having unusual wear-resisting properties. Manganese can also be substituted for some of the nickel in stainless steel.

The "vitamin" analogy I wish to call to your attention, however, relates to the largest use, namely, as an antidote for sulfur. To make steel without sulfur as an impurity is a laboratory feat. When considerable sulfur is present in a low manganese steel, the sulfur tends to combine with some of the iron and the iron sulfide forms films around the iron grains. At the ingot rolling or forging temperatures the iron sulfide has so little strength that the iron grains pull apart and the steel is said to be "hot short," that is, it has low hot malleability. By apportioning the manganese to the sulfur content a remarkable change takes place. The sulfur forms manganese sulfide and, instead of forming films, it forms globules which have little effect on the normal hot malleability of iron. Usually around .4 per cent manganese in the finished steel is sufficient to produce this profound effect. So a pound of manganese makes it practically possible to produce 250 pounds of steel. Thus, a small amount has a large effect and a deficiency would cause substantial impairment in industrial health.

Among the minor metals, tungsten is in a class by itself. It has been the key metal in three industrial revolutions, all during the present century. The first was in connection with high-speed tool steel, the second in lighting and electronics, and the third was another tool material, cemented tungsten carbide.

Tungsten ores are widely distributed throughout the world. Eastern Asia has the most extensive deposits. The United States does not produce enough on an economic basis to meet its requirements but in an emergency it can be self-sufficient. In wartime, however, the demand for tungsten is large and imports are encouraged. Tungsten concentrates are stockpiled against a possible emergency.

In addition to the three fields mentioned earlier, tungsten has many uses. Most make-and-break electrical contact surfaces in automobile ignition systems are tungsten. It is used as a radiation shield; for balancing dynamic systems to conserve space and reduce vibration; in several chemical compounds; for hard surfacing of steel to increase wear resistance and for welding electrodes. It finds an outlet in some steels other than high speed, for example die steels, and it is used as an alloying element in some jet-engine and gas-turbine parts. It can hardly be said, however, that these uses have been responsible for an industrial revolution.

High-speed steel was introduced by Taylor and White at the beginning of this century. By adding about 18 per cent tungsten, some carbon, vanadium, and chromium to iron, followed by a suitable heat treatment, tools are made that retain hardness up to a red heat. This high-temperature hardness made it possible to run lathes and other machine tools so fast that the frictional heat caused the noses of cutting tools to become red hot. A great variety of machine tools were redesigned to take advantage of the increased speed of cutting. The speed-up in machining became so great that a noted mechanical engineer estimated in the 1920's that the United States was capable of producing in five days what, before high-speed steel, would have required six.

The second tungsten revolution was built on the foundation laid by Edison when he invented the carbon-filament electric lamp. The carbon-filament lamp held sway for more than twenty years until feverish research began to encroach on its domain. First, some lamps were made with osmium filaments, then with tantalum, and finally with tungsten. The 1906 model of the tungsten lamp was made with a so-called "sintered" filament which was fragile and brittle. A long research resulted in the production of drawn-tungsten filaments and these were ductile. Ductile tungsten rapidly took command of the incandescent lamp field and it still dominates.

Ductile tungsten also became a key material in electronics. It is used in a great variety of electronic tubes including x-ray tubes. For a time ductile tungsten containing thorium dioxide was used as the electron-emitting filament in radio and similar electronic tubes and when the lower temperature emitters, such as nickel coated with alkaline earth compounds, came in, ductile tungsten was and is used as the "heater element."

It is worthy of mention that a fluorescent lamp today requires more ductile tungsten, per lumen of light output, than does a tungsten-filament incandescent lamp.

The third revolution represented another marked step-up in machining speeds, wire-and-tube-drawing speeds and longer life wearing parts.

In the 1920's Schröter in Berlin produced a hard metal composition by making powdered tungsten carbide and mixing with it about 10 per cent of cobalt. The mixture was formed cold under high pressure to produce briquets. These were heated in a hydrogen atmosphere to a white heat which resulted in a very hard tough material with remarkable properties. There are now many "grades" of cemented carbide, the most important of which have a tungsten carbide base. Tantalum carbide and/or titanium carbide are added to some of the grades for special uses.

For a second time in three decades machine tools were redesigned to take care of the very high speeds made possible by the advent of cemented carbide. Again it may be said that the wide-scale use of these materials is making it possible to produce in five days what otherwise would require six.

Here a small amount of tungsten produces a large effect and a tungsten shortage would result in great impairment of our industrial health.

The last example, germanium, is remarkable not only because a very small amount produces a great effect in the electronics field but also because of new insights in the rapidly growing science of solid-state physics.

Until about fifteen years ago germanium was one of the very rare metals about which little was known. The Bell Telephone Laboratories made a "break-through" when they found that exceedingly pure crystals of germanium with controlled additions of certain other substances in very minute amounts exhibited some astounding electronic properties.

The 1940 edition of *Mineral Industry* has the following to say about germanium. "No use at all has been found for germanium." In the 1949 edition two pages are necessary to tell the germanium story. It was recovered in the United States from the Joplin District lead and zinc ores; from 240 to 2,400 tons were estimated to be contained in the Joplin ore reserves; three companies were producing it and five companies were making germanium electronic end products. Many laboratories, both government and private, were working actively on germanium. Its presence in coal flue dust seemed to be a potential future source as well as ores such as those at the Prince Leopold copper mine in the Belgian Congo.

The end electronic products in highest production are transistors and rectifiers. The former perform the usual functions of vacuum tubes, but are smaller and require very little external power because there is no filament to be heated. Germanium makes possible such things as lightweight hearing aids, portable radio sets, and relatively small electronic "brains." The rectifiers are efficient, small, and when properly constructed and not abused in use, they have long life. Structurally the small germanium crystals are made up with varying numbers of electrodes such as diodes, triodes, and tetrodes to perform the desired functions.

The development of the germanium transistor involved new techniques of purification of metals and resulted in a more sensitive method of assay than the conventional quantitative chemical analysis. Germanium of "commercial" purity is further highly purified by so-called zone melting, that is, melting and freezing progressively in such a way that impurities are concentrated at one end of an "ingot" which can be reprocessed. The purified germanium is ultimately solidified into single crystals.

There must be incorporated into the single germanium crystal minute quantities of special materials in a predetermined geometrical arrangement. Germanium has a chemical valence of four, so a few parts per billion of an element like arsenic or antimony with valence of five provide electrons for conduction, and the incorporation of similar amounts of a valence-three element like gallium or indium provides the equivalent of positive charged electricity conduction. The special geometry is necessary so the positive and negative portions can cooperate to achieve the desired result. As little as one part per billion of these foreign atoms can be detected by electronic means. Thus, not only a new and important industry has been created but a new science is also evolving.

Now silicon is being used in places instead of germanium and many so-called semi-conductors are being evaluated. Silicon retains transistor properties at a somewhat higher temperature than germanium but neither possesses so-called "high temperature capability."

One semi-conductor, however, silicon carbide, has been so prepared that it has efficient rectifier capabilities even at 1,200° F. The field is so new and so potent that one hesitates to hazard a guess about its future magnitude or ramifications. One thing is certain that it will be important. It is certain also that a small quantity of one of these semi-conductors will produce large effects. We

may sometime face a shortage of germanium but never a shortage of silicon.

Manganese and tungsten affect your daily lives. Your transportation, food, clothing, shelter, sanitation, light, heat, and even your entertainment involve the use of steel either directly or indirectly. These things are available at lower cost, in greater abundance, or of better quality because of tungsten. In short, manganese and tungsten contribute importantly to our standard of living.

Such universal importance of germanium cannot now be claimed. We are in the early stages of the semi-conductor revolution. In 1956 about 12,000,000 transistors were used and in 1957 the number exceeded 28,000,000. My eyeglasses represent an example of what germanium transistors are capable of. The frames house a complex electronic instrument. The device contains, among other things, two microphones, two transformers, five capacitors, one battery, one loud speaker, and complete electrical circuit wiring. This miniaturization is made possible by three germanium transistors.

A germanium diode can replace a rectifier fifty times its size. Several dozen miniature germanium diodes can be put in one thimble. Yet these can be made large enough to be called "power rectifiers." Can there be any doubt about the importance of this revolution, in the midst of which we now find ourselves?

Perhaps we can find more rough analogies between man and industry. Man is more complex than an amoeba and also requires for his well-being a greater variety of vitamins, enzymes, hormones, and trace elements. As industry becomes more complex, it requires, for its health, a greater variety of "industrial vitamins." There is no assurance that man may not require still other "health maintainers" in the longer future, but surely others are functioning which have so far not been "discovered." In addition to the many "industrial vitamins" now functioning in our economy, it is certain that new ones will be added as industrial civilization marches forward.

Earlier I seemed to distinguish between nature's products and man's. Is this view justified? If man is a product of nature, is not everything he accomplishes an indirect product of nature? Is man one of nature's media through which many seemingly unnatural things are done? Does it matter greatly whether nature accomplishes by direct or indirect methods? When we observe a great limestone bed we do not hesitate to call it one of nature's geological formations. Yet sea life, like coral, extracted the lime by an intricate chemical process, molecule by molecule, from the prehistoric oceans, thus providing the basis for the present limestone beds. Are they products of nature? Is an electronic brain a product of nature?

The physicists have now concluded that atoms are complex aggregations of subatomic natural entities and that the atom has certain properties not possessed by any of the separate entities. Living cells are complex aggregations of atoms and the cells have properties not possessed by any of of the constituent atoms. Man is a complex aggregation of cells and he has properties not possessed by any of the constituent cells. Society is a complex aggregation of human beings and society has properties not possessed by any individual. Although the gap between the subatomic entities and society is large, is it illogical to suppose that the chain of interdependencies is unbroken and that these rough analogies are not entirely coincidental?

THE PROBLEM OF SEVERE BUSINESS CONTRACTIONS

SOLOMON FABRICANT

Professor of Economics, New York University, and Director of Research,
National Bureau of Economic Research

(*Read April 25, 1958*)

It is to the general problem of severe business contractions that I am to speak. It would be idle pretense, however, to suppose that even within these quiet halls I could avoid paying special attention to the particular business contraction that our economy has been undergoing since mid-1957. We are all too deeply concerned with it. Let me, therefore, concentrate on the current business contraction, and—by commenting on this specific case—provide a view of the general problem.

The business contraction that began in July of 1957 has so far lasted nine months. If it should continue into the fall, it will have reached the preponderant or modal length—about fifteen months—of the twenty-four business contractions that the United States has experienced during the past hundred years. If it should extend into January, it will still be shorter than half the business contractions of the past. We have some distance to go before the present decline can be counted among the longer contractions of our history.

Also important, of course, is the rate of decline. Through March, the latest month for which the figures are generally available, most broad indicators of business activity (seasonally adjusted, we should remember) have fallen from July's level by small amounts. Industrial production is down 12 per cent; retail sales, 6 per cent; and nonagricultural employment, 4 per cent. Unemployment is up from 4.2 to 7.0 per cent of the labor force. But though small by absolute standards, the changes are not small by historical standards. The decline in industrial production, for example, is much greater than the corresponding decline over the first eight months in three of the contractions—those since 1919—for which the index of industrial production is available. It is somewhat greater than in two. It is considerably less than in the remaining two—three, if the short but sharp reconversion contraction of 1945 is included in the comparison. Comparisons of the other measures of business activity tell somewhat different stories. On the whole, however, they join in indicating that the pace of the present contraction has so far been moderate—neither mild nor severe by the standard of history.

The present contraction need not turn out to be long *and* rapid in pace to rank as severe. In an economy such as ours, growing in population and productivity, a moderate rate of decline in output and employment, or even a failure to expand output and employment, must lead to very serious trouble if prolonged. The trouble would be less serious, though serious enough, if the contraction continued at the average rate of decline of the first eight months and long enough to attain average length. Unemployment, for example, would in that case reach or perhaps exceed 10 per cent of the labor force. If recovery then proceeded at the average rate of past expansions, we would have experienced well over a year of considerably depressed activity, and would not have regained 1957 peak levels in production before the end of 1959, and in employment later still.

So far, I must emphasize, the current contraction has been neither long nor rapid, by historical standards. In a third respect, indeed, it has been exceptionally mild. The burden of the contraction has not been as heavily concentrated on the unemployed as in earlier contractions. Unemployment insurance, and the sources of income provided some of the unemployed by pensions and public assistance—and to some extent (depending on timing) also by automatic reduction in income taxes—have in effect helped to spread the burden of contraction over the population at large. This helps to explain the very modest decline, so far, in personal income—1.4 per cent since July.

So far, so good—or at any rate, not too bad.

The question, of course, is whether the current contraction will come to a halt before it has become serious, and I have not really been able to keep this question out of my description of recent events.

One place to seek an answer is in the compari-

son, already mentioned, of this business contraction with the contractions of the past.

Suppose we were to rank the seven contractions that have run their full course since 1919—those for which the necessary statistics can be obtained, excluding the exceptional reconversion contraction of 1945—in order of severity, as indicated by a combination of length and rate of decline. Suppose, then, that we studied the behavior of indicators of aggregate business activity, such as production, employment, income, and prices, as each of these contractions proceeded. We would find—as Geoffrey Moore at the National Bureau of Economic Research has found—that when a business contraction begins, most of the broad indicators of aggregate economic activity show relatively slight declines. During the first five or six months of the contraction the magnitude of these declines seems, in fact, to bear little relation to the ultimate severity or depth of the contraction. Then, however, the percentage declines from the peak month to the current month tend to become larger in severe than in mild contractions, and this ranking is maintained with very little change in succeeding months, right to the end of the contractions.

Comparisons of the same sort can be made also for those types of economic data that typically begin declining before a contraction starts, for example, new orders, construction contracts, and stock prices. In these leading business indicators the distinction between mild and severe contractions begins to appear as early as three or four months after the recession begins.

I have already described, by reference to the aggregate indicators, how the present contraction compares with the earlier contractions eight months after the peak. If we identify the earlier contractions by their ultimate order of severity, and add the information we can get on the leading business indicators, we have one of the clues we are after. The evidence points to a less severe contraction at this time than those that began in 1929, 1937, and 1920. The same evidence indicates that we are in something more severe than the four milder business contractions, those that began in 1926, 1953, 1948, and 1923. The ranking therefore suggests—it is only a suggestion—that the contraction now going on will be of intermediate or moderate proportions, not among the mildest nor among the most severe on record.

Some people seem to feel that business is already leveling off. They may be right. The rate of fall of a few aggregative indicators of business seemed to be retarded between February and March, and retardation is characteristic of latter stages of a contraction. Several of the indicators that usually lead turns in business—stock prices, among them—have lifted their heads a bit. The scope of the contraction has narrowed somewhat—and this, too, is characteristic of the final stages of contraction. Wholesale prices are relatively strong and the consumer price index continues to rise. But these signs of prospective revival are still very weak compared with the signs of further decline; the indexes are all subject to substantial margins of error, so that small changes—and many of the favorable changes are small—are not necessarily significant; and if significant, the changes may reflect the erratic elements affecting most business indicators—erratic elements that cause frequent alternations of direction of change. Until the favorable signs persist, grow stronger, and are joined by others, it would not be prudent to see in them more than a hint of a beginning of the end of the contraction.

Another place to seek an answer to the question whether the current contraction will or could become severe is in the causes of severe business contractions. The tendency for the ultimate ranking of a contraction to make itself evident fairly early suggests that the severity of a contraction is determined in substantial degree by developments that should be visible before the contraction began. Following this line of reasoning, we may note that the current contraction came at the end of a decade of prosperous business. The war ended with a great shortage of capacity in most industries and low consumer stocks of goods of many types—shortages to which the two severe depressions of the 1930's had contributed—and many new families, high incomes, and plentiful liquid assets. There followed huge investments in plant and equipment and in homes and consumers' durables. The contractions that occurred between 1945 and 1957 were mild and conducive to notions of a new era. The investment and consumers' durable goods boom was paralleled—and it encouraged and was encouraged—by a rising market in corporate stocks and real estate and the rapid piling-up of debt. By 1957 the productive capacity of the country had been substantially rebuilt, and vast amounts of additional capacity amassed. Millions of new homes had been constructed, millions of old homes renovated, and new and old homes stocked with equipment.

One cannot yet conclude that a speculative bubble has been blown up to the bursting point, or that the quality of credit has been seriously deteriorated and the structure of debt become dangerously unstable, or that productive capacity in many industries is in excess of needs for years to come. Even if the present contraction should soon come to an end, and recovery carry us to new heights of investment in business and family capital goods, and to new levels in the markets for corporate stocks and real estate, we could not be sure that such a conclusion would then be justified. There are no easy measures of these tensions. It does seem reasonable to suppose, however, that developments during the postwar decade have heightened the probability that the present contraction will be not only more severe than the mild contractions of 1948–1949 and 1953–1954—that already appears to be the case—but significantly more severe. The negative factors I have mentioned must be given more weight today than, say, in 1953. The danger is correspondingly greater that the natural process of adjustment that would bring the present contraction to a close will require more time.

Though there are important differences, developments over the postwar decade are, indeed, distressingly similar to developments during the 1920's, which culminated in the great depression. They are similar, as well, to the developments that are woven into general theories of severe contractions. Whether the appearance of a severe business contraction is the reflection of a self-generating long-cycle process, or the consequence of autonomous causes—wars, misguided acts of government in the monetary sphere or elsewhere, or economic troubles abroad—is as yet not clear. Nor are we clear on the contributory role played by "chance" factors that come into play after the onset of a contraction. But what we know of the causes of severe business contractions does not, on the whole, favor optimism over pessimism, in assessing the present contraction.

It is essential to add this qualification, however: the danger of the kind of financial breakdown that prolongs and deepens depressions has been greatly reduced by improvements in our economic machinery. A major example is the establishment of the Federal Deposit Insurance Corporation.

And there have been other changes in the governmental sphere. Indeed, one can hardly estimate the future course of this contraction—or begin to understand some of the events to date—without dealing with the question of governmental action.

The passage of the Employment Act of 1946 marked the establishment of a national policy in which the federal government is committed "to use all practicable means consistent with . . . other essential considerations of national policy . . . to promote maximum employment, production, and purchasing power. . . ." Discussion since 1946 clearly indicates wide acceptance of this policy by all sections of our people. That the threat of a severe contraction will be met vigorously once it is in plain sight—which may not be until the contraction had reached moderate severity—is therefore very likely. Enough is known about the means with which the battle could be fought—massive public works programs and huge transfers of funds to the public—to leave little doubt of the immediate outcome.

Whether we will be ready to prevent the threat of severe contraction from developing on the other side of the horizon still seems in question, however. Action to accomplish this must be taken in advance, when business conditions are still relatively good. Indeed, if there is any validity in the theory that the causes of severe contractions are bred during prosperity, some action must be taken even before a contraction has begun. This is difficult. Complacency is characteristic of a boom and, to a lesser degree, of the early stages of contraction; the causes of severe contractions are not obvious; information concerning the course of business conditions is scarce, late, and easy to misinterpret; opinions differ concerning the extent to which contra-cyclical policies will do damage to other national objectives (such as limiting government's role in economic life and preventing inflation); and differences in political and sectional interests make trouble at every stage of the deliberations.

The difficulties have been demonstrated by the failure of Congress as yet to accede to the President's request—included in successive Economic Reports—to improve unemployment benefits; to introduce appropriate flexibility, for stabilization purposes, in the roads (and other public works) programs; and to set up a National Monetary Commission.

The difficulties in the way of action before the emergency have been further underscored by recent events and discussion.

Consider, for example, the feeling by some—to which I have already referred—that the contraction is already nearing its close, and that govern-

mental action is therefore unnecessary. It is not impossible that they are right, but, since the preponderance of the evidence does not suggest that the end of the contraction is near, it would be risky to proceed on that assumption.

Others suggest that appropriate action—a tax cut is the best example—might fail to arrest the contraction, and conclude that it should not be tried. What we have learned, over the years, about the determinants of spending for investment and consumption goods does not support the doubt. Nor does the conclusion follow. There can be no guarantee, of course, that a tax cut would increase spending, directly or indirectly, if the factors making for reductions in spending are powerful; or, to put it differently, that a tax cut would stimulate confidence, if confidence is being strongly undermined by other factors. But what evidence there is indicates that confidence has not been greatly impaired, as yet. If the other, depressant, factors are already so powerful that a tax cut would not serve to turn the tide, it is better to know this soon. A tax cut would help to test the level of confidence, and would contribute something to retarding its fall if it is falling.

Another illustration of the difficulties in the way of contra-cyclical policy is the fear of many that it would seriously contribute to inflation. Inflation *is* a possibility. Fear of it should in fact have caused more hesitation than it did when the recent housing credit and highway expansion acts were being considered. In contrast to public works, a tax cut could be expected to affect expenditures immediately, when inflation is not the danger, and reversed later if inflation does become a threat. Responsible fiscal policy to curb inflation will not be easy to follow, but it is not impossible; and the chance of difficulties later should not preclude defensive action to cope with the serious present danger.

It is a serious danger, more serious in some ways than in the past. We seem to be far more sensitive to the existence and consequences of business contraction today than in earlier times. In part, this reflects improved knowledge of current business conditions—inadequate though this knowledge still is. In part, it reflects also higher standards of social responsibility for those hurt most severely in business contractions—the unemployed and the small businessman forced to the wall.

But there is another, perhaps even more important, reason. The communist countries are ready to make capital of economic trouble in the United States. To our allies, aiming at full employment, and to the uncommitted countries, struggling to raise their standards of living, a business contraction in the United States can offer few advantages. It can threaten many disadvantages. A contraction moderate by historical standards would mean a period of something over two years during which our production and employment—and perhaps our imports—remained below peak 1957 levels, while that of the Russians kept mounting. It would provide powerful ammunition for communist propaganda. A contraction severe by historical standards would be disastrous. It would give the communists ammunition to be measured in mega-megatons.

Action to reduce the risk of needing to deal with a severe contraction might not be successful. But it would be well to try. The risk of having to deal with severe contraction is the risk of having to do that which could cause serious damage to the national objectives that distinguish us from the communists—economic and political freedom.

One more word. Much still remains to be learned about business contractions and the best way to deal with them. The present contraction will add one more to our observations; it can stimulate the provision of more statistics; it can induce more active study; it can even put an end to irresponsible talk of the end of business cycles. It is to be hoped that the opportunity will not be lost and that we shall be able to meet the next contraction better armed—better educated—than we now are.

LATE SEVENTEENTH-CENTURY SCIENTIFIC CIRCLES AND THE ABBÉ DE SAINT-PIERRE

MERLE L. PERKINS

University of California, Davis

THE influence of science on the Abbé de Saint-Pierre has been virtually ignored by his early biographers and the recent authors who deal with his famous *Projet de paix perpétuelle* and other schemes. Goumy briefly traces the utilitarian spirit of this *philosophe* to Bacon and mentions his admiration for Descartes.[1] Drouet, describing Saint-Pierre's acquaintance with Bourdelot and other *conférenciers*, neglects the possibility that the Abbé knew other more respected scientists.[2] Gilson remarks only in passing that "contre l'intention expresse du philosophe [Descartes], il [Saint-Pierre] se propose d'introduire sa méthode dans les problèmes de politique."[3] Other writers give even less attention to the matter. To the contrary, new evidence in the present paper permits a more conclusive statement about the Abbé's relationship to the scientists of his day.[4] His notes at Neuchâtel show that late seventeenth-century scientific activities played an important role in his early training and had a bearing on the formation of his moral and political theories.

As a student at the Jesuit *collège* in Caen, 1675, Saint-Pierre read avidly the writings of Descartes and discussed them with his friend Pierre Varignon.[5] In his works he often expresses confidence in the basic principles and implications of the *Regulae* and reveals a good comprehension of them. For him, as for Descartes, all sciences are interconnected and reducible without any fundamental diversity among them to the same degree of certainty, that of arithmetical and geometrical demonstration, "une espèce de calcul arithmétique," "la méthode géométrique," "l'excellente méthode du grand Descartes," which is a standard for measuring proof in every domain (*Ouvrages de politique* **6**: 25; **15**: 85). Before Descartes, "nous confondions et les espèces différentes et les différentes degrés de vraisemblance; et cette confusion était une source inépuisable d'erreurs, de disputes et de mauvais raisonnements."[6] Like Descartes, he rejects the syllogism as a means of discovery and prefers analytic devices. He wants "de l'évidence, et non cette sorte de persuasion qui est l'effet de l'art oratoire" (*Ouvrages de politique* **6**: 114). Premises themselves must be questioned, if one is to penetrate to the heart of a question rather than dispute "de quel sentiment, de quelle opinion était Aristote; ou tel autre homme sujet comme nous à l'ignorance et à l'erreur" (*Epaminondas*, xlvi). He speaks of clear, self-evident principles which require no additional definition, for truth is "simple et naturelle," inaccessible to those "qui pour vouloir trop subtilizer et approfondir les choses, vont au délà de la vérité . . . " (MS. 7929). He has in mind the intuitive grasp of truths as described by Descartes, who "nous a appris à ouvrir les yeux et à en faire usage, et voilà ce que nous lui devons." He refers to other Cartesian tools, enumeration as preliminary survey of ideas, "nous examinons nos idées pour les bien distinguer entr'elles," and deductive chain, "pour les ranger et pour les lier par le raisonnement" (*Epaminondas*, xlvii). Following Descartes' view of analysis, he describes the procedure of "descendre d'un côté dans les détails de la pratique, et de remonter de l'autre par les degrés de la théorie jusqu'au premier principe," that is, initial preview or collection and classification of data, and resolution to a principle, on which is to be built a series of steps to conclusive propositions, with enumeration as comprehensive review to make sure to "remonter

[1] Goumy, Edouard, *Etude sur la vie et les écrits de l'Abbé de Saint-Pierre*, Paris, Bourdier, 1859.

[2] Drouet, Joseph, *L'Abbé de Saint-Pierre, l'homme et l'oeuvre*, 19–24, Paris, Champion, 1912.

[3] Gilson, Etienne, *Les Métamorphoses de la Cité de Dieu*, 209, Paris, Librairie philosophique, 1952.

[4] Notes of Saint-Pierre in the Bibliothèque de la Ville de Neuchâtel have now been examined by the author: MS. 7929. Research for this paper was supported in part by a grant from the American Philosophical Society.

[5] Fontenelle, Bernard Le Bovier de, *Œuvres complètes* **1**: 331, Paris, Belin, 1818; Saint-Pierre, Charles Irénée de Castel, *Ouvrages de politique* **13**: 3, Rotterdam, Beman, 1729–1741.

[6] Saint-Pierre, *Histoire d'Epaminondas, pour servir de suite aux hommes illustres de Plutarque*, xlv, Paris, Didot, 1739.

les propositions comme conclusions jusqu'au premier principe, ou quelque chose d'équivalent . . . " (*Ouvrages de politique* **2**: 129–130; **6**: 24). It is this Cartesian variant of the resolutive-compositive method that Saint-Pierre recommends to complacent "péripatéticiens" as superior to the procedures of all earlier schools:

> l'on sent une grande distance d'esprit à esprit pour l'étendue, la pénétration, l'ordre des preuves et des matières, pour la simplicité et la netteté soit des idées soit des expressions et enfin pour un certain air d'enchaînement des pensées les unes aux autres qui contribuent plus que tout le reste à la clarté, à la vraisemblance, et à la certitude des opinions.[7]

At the same time, Saint-Pierre's knowledge of Cartesian method and his satisfaction with many of its broad tenets in no way mean that Descartes was for him an infallible master. As early as 1692 he questions the value of Descartes' work in most fields:

> Il est vrai que nous avons profité des ses lumières [celles de Descartes] et des routes qu'il nous a découvertes mais aussi nous avons pénétré plus loin et nous sommes environnés d'hommes qui en savent certainement déjà beaucoup plus que lui et pour moi qui me connais un peu en physique, en métaphysique, en morale et en médecine, je trouve que de trente de ses opinions à peine en adopterais-je une telle qu'elle est dans ses écrits (*loc. cit.*).

This attitude does not change. In 1735 he still finds that Descartes' contribution to science was great, but that he failed in many respects as a scientist because of common human weaknesses: "Descartes retomba bientôt dans le train ordinaire de la nature. Et nous voyons qu'il a parlé très souvent d'un ton affirmatif de choses fort obscures et assez incertaines . . . " (*Ouvrages de politique* **5**: 133, 1735). Without accepting Saint-Pierre as an authority, he recognizes the new direction and impetus he gave to scientific investigation. Progress must still lie nevertheless in new experimentation, observation, and discovery, a position which throws doubt on the usual assumption that by embracing the mathematical side of seventeenth-century research Saint-Pierre lost contact with reality.[8] The influence of contemporaries who were themselves correcting and modifying Descartes' views helps explain the orientation of Saint-Pierre's thought, which in some measure represents a reaction to Cartesianism.

The "petite maison" in the faubourg Saint-Jacques where Saint-Pierre and Varignon lived when they came to Paris in 1680 was soon, according to Fontenelle, a center for the vigorous exchange of ideas: "Nous parlions à nous quatre [Saint-Pierre, Varignon, Fontenelle, et Vertot] une bonne partie des différentes langues de l'empire des lettres, et tous les sujets de cette petite société se sont dispersés de là dans toutes les académies" (Fontenelle, 331–332). The Abbé's principal interest at that time was in the natural sciences: "Le principal goût qui m'était resté de la lecture des ouvrages de Descartes et des Cartésiens au sortir du collège était pour l'étude de la physique . . . Je me livrai avec plaisir durant trois ou quatre ans à cultiver cette science . . . " (*Ouvrages de politique* **13**: 3).[9] He made a point of meeting men of science and letters. Varignon, too, because of a small yearly income given to him by Saint-Pierre, was free to "suivre pleinement ses talents et son génie" (Fontenelle, 331). Long before 1687, when his reputation as a mathematician was well established, his advice was sought by men working in other fields. After the *Dialogues des morts* (1683) had appeared and before the publication of the *Pluralité des mondes* (1686), Fontenelle spent several days of each week in the "faubourg Saint-Jacques."[10] With the appearance of the *Histoire des oracles* in 1687, his way was paved to membership first in the Académie Française and later in the Académie des Sciences. The last person to join Saint-Pierre and Varignon was the

[7] Saint-Pierre, MS. 4[4], 17–18: 47. Bibliothèque Victor Cousin à la Sorbonne, autographes des philosophes, l'Abbé de Saint-Pierre à Huet . . . lui parlant de Descartes.

[8] Goumy, 31: "il démontre ou croit démontrer et ne s'aperçoit pas qu'il devrait commencer par regarder autour de lui."

[9] Saint-Pierre, MS. 950, **3**: 215. Rouen.

[10] An unpublished passage from Saint-Pierre's manuscript notes at Rouen gives an intimate impression of their first meeting and subsequent friendship: "En 1683 il [Saint-Pierre] fit un voyage à Saint-Pierre et passa en revenant à Paris à Sainte-Marie du Mont chez la Duchesse de Ventadour sa tante à la mode de Bretagne. Elle lui prêta le premier tome des *Dialogues des morts* de M. de Fontenelle qui venait de paraître dans le public. Cet ouvrage lui donna envie de faire connaissance avec l'auteur qui demeurait à Rouen. Le séjour que M. l'Abbé de Saint-Pierre fit à Rouen pour quelques procès de famille lui donna occasion de lier amitié avec lui. Ils se voient tous les jours et enfin il [Saint-Pierre] l'engagea à venir à Paris et à y fixer son séjour, et pour se voir plus commodément M. de Fontenelle qui logeait chez M. Corneille de l'Académie Française son oncle près de Saint-Roch venait passer trois jours de la semaine chez M. l'Abbé de Saint-Pierre au faubourg Saint-Jacques où il avait une petite maison de 200 livres de loyer" (MS. 950, **3**: 214–215).

Abbé Vertot, who soon had success in treating historical subjects.[11] An atmosphere of enthusiastic cooperation prevailed as the friends gathered information and discussed it with colleagues in a number of intellectual circles. Although they were in touch with literary as well as scientific personalities, the leading figures of the group, Varignon, Fontenelle, and Saint-Pierre, were primarily interested in science. Their ideas and attitudes took shape while they were associating between 1680 and 1700 with very active scientists of the day.

A scientist in his own right, Varignon, although originally inspired by Descartes, felt the need of questioning many of the latter's principles on grounds similar to those the Abbé was to use. In his first important work, *Projet d'une nouvelle mécanique*, 1787, he takes issue with Descartes and Wallis precisely because, neglecting experience, they deal only theoretically with the problem of equilibrium.[12] In his *Nouvelles conjectures sur la pesanteur*, 1690, he states further his opinion of Descartes, "ce grand génie" who taught men no longer to respect "les opinions des anciens philosophes" or even his own, "en nous montrant que dans les sciences il n'y a que la vérité qui soit digne de notre respect." It is often necessary, Varignon explains, to abandon earlier theories "pour ensuivre de plus vraisemblables," and he does not hesitate to poke fun at Descartes. Treating the question of weight, he tells of Mersenne's experiment with a cannon. The latter and Mr. Petit, *intendant* of fortifications, "avaient chargé un canon à boulet," aimed the muzzle straight up, but after firing the shot were unable to find the ball. They repeated the performance several times always with the same results. Varignon comments:

> Des boulets de canon sur notre tête, qui demeurent suspendus sans pesanteur! En vérité cela doit surprendre . . . Cependant M. Descartes qui était accoutumé aux choses extraordinaires, n'en fut point surpris, du moins il le dit, et mande au Père Mersenne, que cette expérience s'accommode le mieux du monde avec sa manière d'expliquer la pesanteur.[13]

Because of his specialized knowledge of dynamics and statics, Varignon distrusts any inclination to ontological argument and on-the-spot invention of causes. Strictly interpreting all nature in terms of matter interacting with matter, he is convinced "qu'il ne s'y fait rien que par mécanique, et que le monde n'étant fait que de matière, ou de substance étendue, tout ce qui s'y passe n'est qu'une suite de mouvements et de figures."[14] Any movement can be gauged and predicted because it is dependent on measurable quantities: "Il ne peut y avoir du mouvement en aucun temps sans une application actuelle de quelque force motrice au corps mû . . . toujours présente à tous les instants du mouvement."[15] These and similar axioms basic to Saint-Pierre's thinking were often introduced in Varignon's discussions with the Abbé and Fontenelle.

A surgeon and anatomist, Joseph Guichard Du Vernay, member of the Académie des Sciences since 1676, frequently visited Saint-Pierre's house to consult Varignon "sur ce qu'il y a en anatomie, qui appartient à la science des mécaniques; ils examinaient ensemble des positions de muscles, leurs points d'appui, leurs directions

[11] In this unpublished passage, while supplying information about Vertot, Saint-Pierre gives insight into the spirit of this household of four Normands: "M. l'Abbé de Vertot . . . avait étudié au collège des jésuites en 1670 à Rouen dans la même pension et presque dans la même classe que moi. Je le retrouvai à Rouen douze ou treize ans après avec M. de Fontenelle chez feue Madame la marquise d'Epinay . . . Deux ou trois ans après étant curé de Croissy et du village de la machine de Marly, il vint me voir au faubourg Saint-Jacques à Paris . . . J'insistai et le priai d'en faire l'essai [d'écrire quelques morceaux d'histoire] et nous lui promîmes, M. de Fontenelle et moi, de lui faire prêter des livres et de revoir toutes les semaines ce qu'il aurait composé la semaine précédente . . . il nous apporta trois sujets dont un était de l'histoire ecclésiastique, et nous choisîmes la révolution de Portugal arrivée en 1640. Il la composa. Je lui aidai à faire le portrait du roi et de la reine de Portugal sur les mémoires qu'il me donna. Son travail réussit, comme nous l'avions deviné . . . " (MS. 7929).

[12] Varignon, Pierre, *Projet d'une nouvelle mécanique avec un examen de l'opinion de M. Borelli sur les propriétés des poids suspendus par des cordes*, aiij, Paris, Boudot, Martin, 1687: "Ces auteurs se sont tous plus attachés à prouver la nécessité de l'équilibre, qu'à montrer la manière dont il se fait. Ce fut ce qui me fit résoudre à prendre le parti d'épier moi-même la nature, et d'essayer si en la suivant pas à pas, je ne pourrais point apercevoir comment elle s'y prend pour faire que deux puissances, soit égales, soit inégales, demeurent en équilibre." This work helped Varignon obtain in 1688 a place as geometrician in the Académie des Sciences and a chair of Mathematics at the Collège Mazarin.

[13] Varignon, *Nouvelles conjectures sur la pesanteur*, 3, 10, 11, Paris, Goudot, 1690. In the articles he gave before learned societies, Varignon regularly quotes Descartes and then disagrees with his opinions. See, for example, *Mémoires de l'Académie royale des sciences depuis 1666–1699* **10**: 71–73, 226, Paris, Compagnie des Librairies, 1730.

[14] Varignon, *Nouvelles conjectures sur la pesanteur*, 3.

[15] Varignon, *Traité du mouvement et de la mesure des eaux constantes et jaillissantes avec un traité préliminaire du mouvement en général* **5**, Paris, Pissot, 1725.

. . . " (Fontenelle, 332). The Abbé profited by these interviews and also took courses in anatomy given after 1679 by Du Vernay, who, as professor in that subject at the Jardin Royal, was one of the most popular lecturers of his time (*ibid.*, 436). When Saint-Pierre began to set down his own ideas on anatomy and health, he submitted his notes to Du Vernay (MS. 7929).

Although Fontenelle did not become "secrétaire perpétuel" of the Académie des Sciences until 1697, he was able before that to introduce Saint-Pierre to other men of science. Many of his close friends, besides Varignon and Du Vernay, were either members or were to become members of the Academy of Sciences, including Jean Méry, Daniel Tauvry, Nicolas Lémery, Pierre-Sylvain Regis, the Marquis Guillaume-François de l'Hôpital, Jean-Dominique Cassini, Philippe de la Hire, Sedileau, and Jean Picard, names which the Abbé mentions and which appear regularly in accounts of the activities of the Academy between 1680 and 1700 (MS. 7929; *Ouvrages de politique* **5**: 324). Most of these men, moreover, attended, as did Saint-Pierre, the academy of the Abbé Bourdelot, a popularizer rather than a serious scholar, whose circle, nevertheless, was a gathering place for many practicing scientists.

Jean Méry and Daniel Tauvry, both anatomists and surgeons, won notoriety by their dispute over the circulation of the blood in the foetus. The first had a reputation for careful observation: "il voyait les faits d'autant plus sûrement, qu'il ne les voyait point au travers d'un système déjà formé qui eût pu les changer à ses yeux." In the company of Fontenelle, Saint-Pierre must have more than once visited Méry's study with its anatomical treasures, "jusqu'à quatre-vingt d'importantes [pièces], soit squelettes entiers, soit parties d'animaux," thirty of them concerning man, some of which had "tous les nerfs, conduits depuis leur origine jusqu'à leurs extrémités . . . " (Fontenelle, 327). Tauvry, on the other hand, had "le don du système" and "le talent d'imaginer heureusement les usages des structures . . . " (*ibid.*, 53). After a talk with him one day Saint-Pierre rejected three systems to explain the circulation of the blood, even though they were "assez ingénieux," because they failed to give an ultimate cause, "la première cause des causes qu'ils rapportent" (MS. 7929).

Nicolas Lémery, chemist and doctor, won the Abbé's admiration by his vast knowledge of drugs and compounds. Long recognized as a helpful tool in the field, his *Cours de chimie*, first published in 1675, had thirty-one editions. Fontenelle speaks of him as "le premier qui dissipa les ténèbres naturelles ou affectées de la chimie . . . " and says "les Rohault, les Bernier, les Auzout, les Regis, les Tournefort" studied chemistry under him (Fontenelle, 187–188). When Saint-Pierre took his course, "j'allais aux cours de chimie de feu M. Lémery," it was given in the latter's lodgings "dans la rue Galande" and was so popular "il s'en fallait beaucoup que sa maison fût assez grande pour loger tous ceux qui le voulaient être, et les chambres du quartier se remplissaient de demi-pensionnaires . . . " (*Ouvrages de politique* **5**: 324; Fontenelle, 188). This enthusiasm arose in part from the dramatic quality of Lémery's experiments. One of them in fact was reported in the *Histoire de l'Académie*, 1700, simply to illustrate the method and value of experimentation, because the best way of explaining nature "ce serait de la contrefaire. . . . " Lémery, it seems, to reproduce the effects of a volcano had buried in the ground "à un pied de profondeur, pendant l'été, 50 livres d'un mélange de parties égales de limaille de fer, et de soulfre pulverisé, le tout réduit en pâte avec de l'eau." After eight or nine hours, startling events and claims, "la terre se gonfla, et s'entrouvrit en quelques endroits, il en sortit des vapeurs soulfreuses et chaudes, et ensuite des flammes." Lémery had created "un Etna ou un Vésuve."[16]

Much of the important work of the Académie des Sciences during the last twenty years of the century was done by astronomers the Abbé knew personally. Cassini, the leading investigator in this field, successfully predicted in 1680 that a comet of that year would follow the course of the comet of 1577 observed by Tycho-Brahé (Fontenelle, 171).[17] In 1691 he was completing his observations of Jupiter and its satellites and discovering the periods of movement of that planet. During the next few years he improved methods for determining longitude and latitude, studied eclipses of the sun and moon, and discovered new satellites of Saturn (*Mémoires de l'Académie des Sciences* **10**: 1–3, 150, 694). His co-workers, to whom Saint-Pierre often refers, were Roemer, Picard, de la Hire, and Sedileau.

[16] *Histoire de l'Académie Royale des Sciences, Année 1700*, 51, Paris, Boudot, 1703.

[17] *Histoire de l'Académie Royale des Sciences, 1666–1686*, **1**: 332, Paris, Martin, Coignard, Guérin, 1732.

The prestige of this research and its support by the government were assured by the practical results expected of it, "de perfectionner la géographie . . . de rendre les cartes beaucoup plus correctes . . . " (*Histoire de l'Académie des Sciences* 1: 336).

Reflecting the activities of these astronomers and of the surgeons, chemists, biologists and mathematicians he frequented, Saint-Pierre's *Pensées diverses* requires detailed treatment and presentation.[18] Unpublished, the document is particularly useful for the information it gives about the Abbé's own study and research. He writes about a multitude of topics, perception, health, inventions, the flora and fauna of remote regions. These loosely arranged notes, which reveal the wide range of his curiosity, offer substantial evidence of his participation in the scientific current of the last part of the seventeenth century.

Assuming a distinction between impressions forced upon men by their natural beliefs on the one hand and understanding derived from an analysis of experience on the other, he disagrees with Regis over the extent of man's illusion with respect to secondary qualities of objects.[19] The latter holds that most men are accustomed to "rapporter le sentiment des couleurs aux objets colorés." The Abbé believes men have become sophisticated enough to overcome this literal attitude. They do not think the feeling is in the object, "mais les causes de ce sentiment conçues confusément." When they attribute sadness to a room, they are not speaking strictly. They mean the room is the cause of sadness. Similarly, a fire is hot, a table hard, not because these things have such properties, but because "en la touchant [la table] nous avons le sentiment de dureté, le feu est la cause du sentiment de chaleur" (MS. 7929). Color, hardness, warmth exist for the mind as a result of its union with body, but man does not equate knowledge merely to seeing or touching. His reflective powers play an important part in the acquisition of knowledge.

Turning to a new subject, he reports a discussion with Tauvry about the circulation of the blood, "l'autre jour je dis à M. Tauvry un système ébauché pour expliquer le mouvement du coeur, j'y ai repensé depuis" (MS. 7929). In search of a general principle, he mentions various phenomena which seem pertinent. He knows of work done on live frogs by Leeuwenhoek, who has seen "la veine et l'artère ne faire qu'un même canal" and claims "avoir vu passer le sang goutte à goutte d'un côté du tuyau dans l'autre" (MS. 7929). He recalls the effect of capillary attraction during the overflow of the Seine:

> Dans le débordement de la Seine à Paris cette année 1690 il est arrivé que les caves en plusieurs endroits du marais et ailleurs comme les caves de l'hôtel de Guise se sont trouvées remplies d'eau non pas lorsque la Seine était dans son plus grand débordement mais plusieurs jours aprés qu'elle avait commencé à décroître, et même cette eau croissait dans les caves lorsque la rivière n'était plus débordée (MS. 7929).

He takes notice of the shifting about of smoke trails from chimneys. The explanation he finds most satisfactory is by analogy with rivers and fountains:

> J'ai trouvé quelque ressemblance entre ce mouvement perpétuel des fontaines et le mouvement du sang. Le boire et le manger réparent la perte du sang qui s'est faite par les pores et sont au sang ce que la pluie est aux fontaines, la différence est que l'une vient par la nécessité des loix de la mécanique et l'on voit que l'autre vient en conséquence du sentiment de la faim et de la soif (MS. 7929).

He adds a word of caution, "mais ne nous arrêtons point aux ressemblances puisqu'elles nous obligeraient à démêler les différences."

The human life span, a problem being debated

[18] The portion of Saint-Pierre's papers at Neuchâtel with the heading *Pensées diverses, 1689*, bears this remark in his hand: "J'ai donné une copie de cet écrit à M. Du Vernay en juillet 1690. J'ai quelques réflexions à y ajouter" (MS. 7929). The dates and the last sentence are of interest because they show the Abbé's active concern with science persisted after 1687, the time when he is usually thought to have turned to ethics, and probably well after 1690, when his interest in political science was becoming strong.

[19] A disciple of Rohault, the well-known admirer and teacher of Cartesian doctrine, and a friend of Lémery, Pierre-Sylvain Regis came to Paris in 1680 and began to give a series of talks on Descartes which had immense popularity. Saint-Pierre attended many of his lectures until their suspension by order of the archbishop of Paris "par déférence pour l'ancienne philosophie." In a quarrel about optics with Malebranche, 1693, Regis maintained that the size of an object depended "uniquement de la grandeur de son image tracée sur la rétine . . . " Malebranche, who had been a frequent visitor to Saint-Pierre's lodgings, held that size depended also "du jugement naturel que l'âme porte de son éloignement . . . " (Fontenelle, 91–92). Varignon and le Marquis de l'Hôpital, one of the first with Varignon to develop infinitesimal analysis, supported Malebranche in this matter (*ibid.*, 93). Involved with Regis in an argument over a similar problem, Saint-Pierre, like Malebranche, stresses the role of man's reflective powers.

by Méry and others at the time, disturbs the Abbé because he can find no certain cause of its shortness and refuses to admit that "l'âge des hommes soit borné." If age appears to be limited, it is not by "la nécessité des loix de la nature," but by man's ignorance "des régimes et des remèdes." Mustering evidence that life may be prolonged, he asks why "avec les remorques de l'art ne pourrait-on pas arriver à l'âge de ce puissant Anglais de notre siècle qui a vécu 152 ans sans faire aucune attention ni à ce qu'il mangeait ni à ce qu'il buvait ni à son travail ni à son dormir" (MS. 7929). Confident that man may find "le secret de vivre mille ans," he considers the causes of growth and decay. Health for him is movement, which "creates heat in the body, distributes the humors, and causes transpiration through the pores." Exercise accelerates growth by forcing ingredients "propres à nourir les os" to enter them at an increased rate. Growth is impeded by the hardness of the bones and the firmness of the flesh, which limit the size of the human body and prevent a race of giants from appearing. He thinks decay results in large part from inactivity, but has difficulty explaining tooth decay by this principle. Remedies of all kinds fascinate him. He is especially inquisitive about cures for "les fièvres intermittentes," because of their effect on the imagination. Experimenting with his own health, he learns to follow a definite regime. To bed at eight in the evening, he gets up at four in the morning. Because of the relation he sees between health and movement, he does his studying in the mornings and keeps the afternoons free for walking, visiting with friends, traveling by carriage. As for food, he limits himself in the morning to bread and butter at seven, but drinks "une chopine de vin" and "deux pintes d'eau." At other meals he eats sparingly. He attributes his freedom "des maladies douloureuses de gravelle et de goutte" to diet and exercise and thinks he can cure himself of most sicknesses "en mangeant très peu et buvant beaucoup d'eau chaude" (MS. 950, **3**: 219).

References to machines and experiments abound in the Abbé's notes. Near Charleville a mill is operated by a new form of lever:

> pour mouvoir la meule de dessus qui doit moudre il y avait un grand plancher fort large horizontal ou à peu près et que le petit garçon assis vers l'extrémité du plancher et en l'air avec le pied pouvait pousser ce plancher lequel après qu'il avait une fois reçu le mouvement continuait de se mouvoir et le petit garçon l'entretenait aisément en donnant de temps en temps un coup de talon à quelque aileron du plancher (MS. 7929).

The Abbé estimates the consequences of such an invention.[20] The tools used for experimentation in astronomy attract his attention. He has examined the "baromètre double de M. Huygens" and the barometer of Cassini, "M. Cassini nous fit voir son baromètre." He refers to "expériences de juillet 1689 que j'ai vues" by Cassini. He wonders about the speed of light and sound and cites Huygens' *Traité de la lumière*, which he has been reading. He mentions work by Picard on the same subject, and then writes: "Son—vitesse de—et de la lumière—M. Roemer."[21] Roemer did determine the speed of light. At a time when Cassini and others are making the observations of Saturn which led to discovery of the two satellites closest to that planet, Saint-Pierre tells of a conversation with M. de Lafaye, who "m'a dit que l'anneau de Saturne n'a point de mouvement particulier."[22] Speaking of the magnet, one of Lafaye's principal research projects, the Abbé thinks Descartes' work on this matter must be extended and is gathering details and drawings of "la machine de M. Puget Lyonnais pour les expériences de l'aimant" (MS. 7929).[23] He speaks of Sedileau's work with the compass and says that "M. de la Hire observa à Antibes qu'un segment de cercle de cuivre sous une aiguille aimantée la faisait varier sensiblement, peut-être qu'un segment d'autre cuivre n'aurait pas fait le même effet" (MS. 7922). He believes that much additional data must be accumulated before sound conclusions can be reached.

The Abbé's thirst for information about living conditions, animal and plant life, climate and topography in other parts of the world is insati-

[20] Interest at this time is keen in applying mechanical theory to labor-saving devices. See, for example, *Histoire de l'Académie des Sciences, 1686–1699* **2**: 14, 33–35.

[21] Olaüs Roemer, a Danish astronomer, participated in the Academy's work by letter and visit.

[22] Jean-Elie Leriget de Lafaye (1671–1718), soldier, geometrician, specialist in mechanics and experimental physics, was admitted to the Académie des Sciences in 1716. Among the "curiosités" which he kept in his study was a loadstone weighing two thousand pounds.

[23] In 1687 Cassini and de la Hire reported "Sur les phénomènes de l'aimant" and "on lut un mémoire des expériences nouvelles sur le même sujet faites à Lyon par M. Puget, lesquelles ont été publiées depuis" (*Histoire de l'Académie des Sciences* **2**: 18). Louis de Puget, one of the founders of the Academy of Lyon, published *Lettres écrites à un philosophe sur les effets de l'aimant*, 1702.

able. He inquires about voyages to the Far East, the West Indies, South America and North America. Under the heading "Extrait d'un voyage de Siam de 1687," he notes "variations de la boussole, selon les degrés de la longitude et de la latitude" (MS. 7929) and gives details about the winds and tides as they affected the voyage. He tells of huge elephants which in spite of their size "courent plus vite qu'un homme qui court bien" and adds that "il y a des tigres dans les forêts de Siam grands comme de petits chevaux, ils n'attaquent guère, ils fuyent au bruit et au feu comme nos loups." His source is the *Relation de l'Ambassade du chevalier de Chaumont à la cour du roi de Siam*.[24]

Saint-Pierre's picture of Florida includes black and white mulberry trees, silkworms, "des muriers blancs et noirs où il y avait des vers à soie," which "Ribaud trouva," crocodiles, hermaphrodites, "selon Laudonnière," and the prevalence of syphilis among the natives. He describes the volcanoes of Mexico, the seasons of Peru, the sugar of Chile, its pearls, salty rivers, the fish and whales of its coasts. He mentions seals off Santo Domingo twenty feet long, its "lac de dix-huit lieues de long sur deux de large, l'eau salée comme celle de la mer," and "les chiens muets" which the natives use in hunting. His materials are taken for the most part from Jean Ribaud's *Histoire mémorable du dernier voyage aux Indes, lieu appelé la Floride*, Londres, 1563, and René Laudonnière's *Histoire notable de la Floride, contenant les trois voyages faits en icelle par des capitaines et des pilotes français*, Paris, 1586.

The Abbé's principal source for the Eastern seaboard of North America, including Newfoundland, the Grand Banks, Canada, Nova Scotia, and New England, is "Denis dans sa relation 1672." He speaks also of "Estienne Parminie Budée dans sa relation de l'île de Terre-Neuve" (MS. 7929). "Denis" is Nicolas Denys, governor for the king in the Newfoundland area. His book is in two parts, the first, *Description géographique et historique des costes de l'Amérique septentrionale*, and the second, *Histoire naturelle*, both published in 1672.[25] Budée or Stephanus Parmenius Budaeus, a Hungarian "born in the city of Buda," is much less informative, but of some significance as a source.[26] His poem *De Navigatione*, written in 1582 to celebrate the departure of Sir Humphrey Gilbert to establish an American colony, glorifies Gilbert and the English without giving much information about Gilbert or the proposed voyage.[27] On August 6, 1583, however, in a letter to Richard Hakluyt from Saint John's in Newfoundland, where Budée had accompanied Gilbert, he gave details about the fishing, trees, grass, soil, plants, animals, and climate of the region. He was drowned the same year with Gilbert and many others in a shipwreck, and Hakluyt included the letter, Saint-Pierre's source, as well as the poem in his account of the voyage. Hakluyt's *Voyages, Navigations, Traffics, and Discoveries of the English Nation*, first published in 1600, is the only likely vehicle for the Abbé's knowledge of the Budaeus letter, which means that he probably had at his disposal in studying foreign lands a work that could give him detailed information about almost every part of the globe.[28]

Although Saint-Pierre was one of the first *philosophes* to seek inspiration in the scientific movement of his age, the extent and nature of his interest in science have not been determined in the past. Partly on his own initiative, partly through Varignon and Fontenelle, he met many men of science between 1680 and 1700. Some of them, like Bourdelot and Regis, were primarily

[24] *Relation de l'Ambassade de Mr. le chevalier de Chaumont* [Alexandre, Marquis de] *à la cour du Roi de Siam avec ce qui s'est passé de plus remarquable durant son voyage*, Paris, Seneuse, 1687. This is apparently the edition the Abbé used. First published in 1686, Amsterdam, by Mortier, this work describes in a day by day account Chaumont's voyage from Brest to Siam in 1685, his brief stay there and return in 1686. The route of the voyage is carefully recorded at the end of the book in charts giving compass directions and distances traveled. Climatic conditions during the voyage are mentioned. There is an account of the government, customs, religion, and commerce of Siam and of neighboring countries. Characteristics are given of tigers, elephants, and other animals.

[25] Denys, Nicolas, *Description géographique et historique des costes de l'Amérique septentrionale* **1**, Paris, Billane, 1672; *Histoire naturelle des peuples, des animaux, des arbres et plantes de l'Amérique septentrionale* **2**, Paris, Barbin, 1672.

[26] Hakluyt, Richard, *Voyages, navigations, traffics and discoveries of the English Nation* **3**: 156, London, Bishop, Newberie, Barker, 1600.

[27] Budeii, Stephani Parmenii, *De Navigatione Illustris et Magnanimi Equitis Aurati Humfredi Gilberti, ad deducendam in novum orbem coloniam suscepta*, Londini, Thomam Perfutium, 1592.

[28] Hakluyt, *ibid.*, 161–163. The headings and marginal indications referring to explorers and the lands they visited are complete and make it easy for a person with only a minimal knowledge of English to select important passages for translation or synopsis.

popularizers. They could stimulate his interest in science, although they were more inclined to create systems than to observe and analyze carefully. Other men were more cautious in their attempts to gather and assemble fragments of information about a machine-like universe. Du Vernay, Tauvry, Méry, and Lémery reported regularly to the Académie des Sciences. The Abbé knew other scientists even more respected and honored for soundness of method. He attended experiments by Huygens and Cassini. He conversed with Sedileau, De la Hire, and probably Picard. He was familiar with work done by Leeuwenhoek and Roemer. He made inquiries about astronomy, chemistry, botany and zoology, the instruments utilized by these sciences, and parts of the world not too well known to his contemporaries. These years of research seem to have shown Saint-Pierre the need for strengthening the inductive side of Cartesian method, that is, enumeration as preliminary survey and collection of data. He became convinced that experimentation, observation, and reasoning should go hand in hand: "la raison et l'expérience doivent être inséparables pour la découverte des choses naturelles" (MS. 7929). To these early studies the Abbé liked to attribute the characteristics of his thinking and method in government:

> Je crois devoir à ces exercices l'habitude à l'application; la docilité à tout écouter, à tout examiner; la facilité à changer d'opinion, quand j'en apercevais une plus vraisemblable; la fermeté à garder mon opinion, tant que je ne trouvais rien de plus vraisemblable . . . Si j'y ai acquis [dans la science du gouvernement] quelques connaissances utiles, je crois les devoir à ces trois ou quatre années d'exercice de mon esprit dans l'étude de la physique" (*Ouvrages de politique* **5**: 324).

Although Saint-Pierre's statement about influence may appear too broad to carry much meaning, there is some evidence that such training did help form the Abbé's approach to moral and political questions. First, like the physical sciences, ethics and government must be founded, he thought, on experience and reasoning rather than on ideal notions of proper behavior. For his moral and political theory he relied above all on knowledge of anatomy, physiology, and behavior acquired from scientists with whom he associated, books dealing with the customs of many lands, and from his own observations. Moving about the city after 1687, settling "en différents quartiers en chambre garnie," he spent much of his time studying the people in various sections of Paris: "Mme de la Fayette . . . sachant qu'il étudiait les caractères des habitants du quartier du Marais comme on étudie un livre lui demanda un jour en plaisantant, quand aurez-vous donc entièrement lu votre Marais pour venir lire le faubourg Saint-Germain" (MS. 950, **3**: 216). Surgeons and doctors were importuned for information. Reports of abnormal attitudes and conduct were recorded and analyzed in search of causes and cures.[29] Second, his explanations, like the science of the day, are mechanistically oriented. Happiness is viewed more as a problem of the proper functioning of the bodily machine than as a product of philosophy. He speaks of mental states, melancholy, for example, in terms of physical movement: "Il y a dans les personnes de constitution différente des causes différentes de cette indisposition, mais en général je croirais facilement qu'il y a quelque disette d'esprits animaux, ou quelque interruption ou obstruction, dans le cours de ces esprits . . . " (MS. 7929). Government is a machine designed to produce the felicity of man: "la machine politique va naturellement tous les jours, en se fortifiant par la multiplication de bons règlements, qui sont de nouveaux ressorts qui fortifient les anciens" (*Ouvrages de politique* **6**: 34). Because of this attitude, he is led to confine his research in political science to observable aspects of man and his condition, namely the corporeal machine of man, the passions or parts of the soul which have bodily correlates, and the physical bonds of government. Just as his contemporaries in the physical sciences are looking for universally applicable mechanistic laws, so the Abbé is looking for a principle of force applicable under all circumstances rather than for a passionless standard. He finds fear and desire to be the basic passions, and fear the means of bringing

[29] Saint-Pierre sees in early conditioning one of the main causes of unhappiness in man, which he equates to emotional distress. As an example he cites the case of Hobbes who admitted that "les contes effrayants d'esprits et de revenants qu'il avait entendu faire à sa gouvernante, qui s'en effrayait elle-même en les contant, lui avaient fait tant de peur et tant d'impression, que durant toute sa vie, qui a duré plus de quatre-vingt-dix ans, il n'a jamais pu se résoudre à coucher seul la nuit dans une chambre; car pour le jour, il avait assez de courage pour y demeurer seul" (*Ouvrages de politique* **5**, 113).

men under control: "les hommes ordinaires ne consultent guère dans leur conduite ni les maximes de la religion ni les idées de la philosophie; ils ne les regardent que comme de pures spéculations; aussi n'ai-je pas appuyé sur ces sortes de motifs qui ne sont proportionnés qu'à peu de gens: j'ai opposé passion vulgaire à passion vulgaire . . . "[30] Desires which lead to violence can be "contrebalancés par des craintes encore plus vives" (*Projet* **2**: 78). Passions are movements which can be measured and checked by artifice: "qui peut retenir un homme emporté par le mouvement d'une passion injuste? Une seule chose, c'est un mouvement contraire causé par une passion plus forte . . . La loi est réduite à faire naître en lui la crainte d'un mal plus fâcheux et plus terrible que le bien qu'il désire ne peut paraître désirable" (*ibid.* **1**: 20–21). The concept is largely mechanistic and experiential.

[30] Saint-Pierre, *Projet de paix perpétuelle* **2**: 106, Utrecht, Schouten, 1713.

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